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NEW YORK, NOVEMBER 28, 1895.

EDITORIAL NOTES.

CONDUIT systems seem to be attracting considerable attention in different quarters; and it may be confidently expected that the coming year will see unusual activity in this line. Two are now in operation in the United States, the "Love" system in Washington and the Lenox Avenue Line, constructed upon a closely similar plan, in New York. It is now rumored that a number of cable companies are looking to the substitution at an early day of wires in lieu of their existing cables. So far all these new systems are going in upon an open-slotted conduit plan, with continuous bare conductors. This, with one exception—the Madison or Fourth Avenue Line, in New York—will give the accumulator system another chance.

Philadelphia, however, which has always been in the lead in traction matters, and taught us in New York how to lay and run a cable, has probably taught us an expensive lesson; that city will have no cable now, and no conduit of any kind, but has surrendered nearly all its lines to the overhead trolley, which is being installed everywhere as fast as possible, while the cables are coming up; and doubtless this bit of history will erelong be repeated here. We shall continue to hope that in the rush for something new we shall somewhere see at least one closed conduit system tried having a sectional midrail conductor, without bare wires anywhere.

THE article in another column describing a new form of fire-brick fire-box for locomotive boilers is suggestive of the attempts that have been made for a number of years to do away with the expense and inherent evils of the fire-box as it is now constructed. It seems to have been demonstrated that an evaporative efficiency equal to the present fire-box can be obtained with the brick-lined arrangement, but there must be some practical objections in the line of maintenance that are developed in the course of the experiments that are either belittled or concealed. The brick arch has shown itself to be so valuable that it is taken as a matter of course, and yet there are some roads that have been compelled to abandon it on certain divisions owing to the combination of bad water and bad coal rendering it impossible to support the brick. The tubes will fill with mud and scale despite the rapid circulation that passes through them. But though abandoned in some places, the brick arch continues to hold its own. It would seem probable, then, that it only remains to devise some means to hold the brick of a lined furnace securely in position beyond all possibility of a collapse in order to bring this old system that is continually cropping out in new forms into practice to such an extent as to give so thorough a demonstration of its value that it must survive or perish with the results.

THE introduction of the electric locomotive for ordinary railway work will bring many new and interesting problems before the designer of these engines. So novel do these electric engines look, that one recognizes hardly a single familiar feature of the large old-time locomotive. A peculiar point in the design of the Baltimore locomotive arose from the necessity of making some provision whereby the swaying and side thrusts that must necessarily take place on curves should not be allowed to seriously displace the revolving armature in the field of the motor. The armatures of these multipolar motors are on the axles of the drivers, and turn with the latter; they are not, however, rigidly secured to them, but are fastened by yielding connections which allow the axle of the driver to be considerably out of the true centre line of the armature, but without displacing the latter with reference to the field of the motor. Problems like these are new to locomotive engineering, and will doubtless be productive of an entirely new school of design.

Where boiler and water are both absent from the locomotive, other means must provide for this loss of weight in order to maintain the necessary tractile powers. Hence we find in the Baltimore engine very heavy frame-work for the trucks, and the motor fields are very massive, and the centre of gravity of the whole structure can be brought much lower in the electric engine than in the steam locomotive, where the weight of boiler and water must generally be altogether above the axles of the drivers. In the electric locomotive it will be far easier to use drivers of 8 ft. or 9 ft. in diameter, or even more; inasmuch as the centre of gravity can easily be brought below the axles, we can obtain the same degree of steadiness with drivers of much larger dimensions than those in common use to-day. The utter lack of tender and all reciprocating machinery are alike conducive to simplicity of design as well as comparatively low cost. On the other hand, motor dynamos will also be used for supplying light to the trains, and the air-brakes will probably be operated by compressed air, the pressure of which will be supplied by air compressors driven by electric motors.

All these features combine to introduce entirely new and highly interesting problems of design in the arrangement and construction of the coming electric locomotive.

ELECTRIC RAILWAYS.

IT is now only seven years since the first trolley line was put into operation, with grave doubts and misgivings as to its future. No single development in the engineering world, however, has seen such rapid growth and well-deserved success. Since the first trolley in Richmond, Va., itself a financial failure at the outset, more than 800 trolley roads have gone into operation throughout the United States on the lines of a system long regarded by eminent engineers as of doubtful value.

The growth of the trolley in this country has been unique, in that it has in a sense created its own field and made its own

market; and while city traction systems seem to be slowly but almost certainly coming over to electricity, as evidenced by the recent change in Philadelphia, this departure has been only secondary to the great demand for new roads in suburban districts, which by their invariable selection of an electrical system have given the trolley a chance to establish its merits on a foundation so secure that city systems, where, for one reason or another, a change must be had, are gradually turning to the trolley for a solution of their difficulties.

We shall aim to keep our readers in touch with this development from both the railroad and the engineering point of view; and while we are not among those who look for electricity to displace steam in general railway traffic, even in a remote future, as some of our more enthusiastic contemporaries would have us believe, we are fully alive to the growing importance and value of these new systems and of their daily increasing interest to both the civil and the mechanical engineer. We shall not endeavor to give a technical review of electrical progress—this is the province of the electrical paper pure and simple; but shall keep close track of such practical advance as will prove of immediate interest to the railway mechanic and engineer.

A consideration of practical applications and different systems of railway and car construction and motors, as well as central station detail and management, will come within our province, and we will thank our readers for information of any new developments that come to their notice.

While it is hardly safe now to predict in this country the early advent of the so-called "underground trolley" systems, their recent adoption on two important lines of New York City appears significant, and may give a stimulus to this type of system that will lead to radical change and interesting developments in city systems, where the overhead wire will always be more or less objectionable. If the Lenox Avenue Line, in New York, with its bare conductors less than 2 ft. apart in an open or slotted conduit, should work satisfactorily or even without interruption through the winter, we may expect to see a degree of confidence restored to systems of this class which repeated failure and defeat have shaken in former trials. It is to be hoped that these failures were the fault of defective construction, and not inherent in the system.

The present advance lies evidently in this direction, for close upon the heels of the Lenox Avenue experiment we are informed that another uptown avenue line—not in the Metropolitan syndicate—is to lay a slotted conduit underground trolley system. Significant among the changes to electric systems is the proposed alteration of the switching systems at the ends of the Brooklyn Bridge. This service has heretofore been performed by steam motors handling 75 trains an hour.

It is stated that an overhead trolley system will be installed, the bridge construction being well suited to an overhead wire system. Will it be, indeed, a rash prediction that this change is only a precursor of a more radical one in the near future—that of the entire bridge cable to a "midrail electric system," to the construction of which the bridge road is well adapted.

In the past year the most eventful feature in electrical engineering has been the equipment of the Baltimore tunnel with electric locomotives designed to haul for a few miles the regular traffic of the Baltimore & Ohio Road. Two electric locomotives, properly so called, as they weigh 96 tons, will perform this service, taking both the fast express and the heaviest freight trains through the tunnel under the city at the customary speeds. Being the first locomotives designed to do the work of the heaviest steam locomotives, their performance will be watched for some time with continued interest. Recent reports of very severe tests are of the most encouraging sort, and the fact seems established beyond the peradventure of a doubt that an electric locomotive for any desired work can now be built.

Probably the next step in heavy railway work will be in the line of a high-tension system, either by direct or alternating currents having a voltage of a thousand or more, sufficient at least to insure economical operation over 10 miles or more either side of a central station. Such a system has already been projected, that proposes the use of two direct currents of 500 volts each on the two sides of a three-wire system, a 500-volt motor of the ordinary type being placed on each side of the middle wire in precisely the same manner as two 110-volt lamps either side of the neutral wire use the 220 volts of a three-wire lighting system.

Other projected plans contemplate the use of high-tension multiphase alternating currents transformed at intervals to low-tension direct current by rotary transformers.

Although the horseless carriage seems to have surrendered at discretion to the gasoline or petroleum engine, the storage battery in this field is not going to surrender without a fight.

Notwithstanding the fact that in the recent competition in France the vehicles driven by storage batteries made a rather poor showing, we are pleased to learn that the coming competition to take place the last of this month between Chicago and Milwaukee will find at least one electrically driven vehicle of American manufacture in the race.

RAILROAD RACING.

It is evident that a finality has not yet been reached in the matter of fast time on railroads. The public want to travel as fast as possible, and this constant demand is almost certain to influence railroad managers sooner or later, and lead them to give those who travel the fastest possible or practicable trains.

The question is now constantly asked: What is the limit of practicable railroad speed? To which there is not likely to be a final answer given for some time to come. Railroad managers in this country and in Europe are casting about for means of accelerating speed, and there will quite certainly be a continued demand for locomotives which will make faster trains possible. It will be assumed that such a demand has been made and that a locomotive superintendent is required to supply a train to run, say, 70 miles per hour in regular service on a fairly good road. Now, how could this be done?

In reply, it may be observed that if a person should engage in horse racing he would not be likely to select his horses from those best adapted to ordinary coach service, nor would he harness them to a heavy stage coach or omnibus. He would choose a horse with good lungs, light legs, and plenty of muscle. A heavy-limbed, big-bellied and cumbrous beast would not be likely to make fast time. Having his horse, he would hitch him to the lightest of vehicles—like the gossamer-wheeled buggies for which we are noted in this country.

Now, in undertaking to make fast time on railroads, have our locomotive superintendents and railroad managers shown the same kind of sagacity that any horse jockey would exercise if he undertook to win a race or to throw dust into the eyes of his rival out on "the road"? Is it not a fact that the locomotives which have been employed in the notable fast runs in this country have generally been of the class adapted to haul heavy passenger trains at ordinary express speed, and the cars which have composed the train behind the locomotive have been some of the heaviest in day service? The jockey would lighten the load of his horse; but have the railroad managers shown the same kind of astuteness? Or, to put our inquiry into a more definite form, could the fast express trains which have been run in this country be materially lightened and yet carry the same number of passengers that they now do and give them all the accommodations that may reasonably be demanded, and at the same time not diminish the safety of cars in case of accident? It is to such an inquiry that the present article will be devoted.

The weight of the cars which composed the train which made the fast run from Chicago on the New York Central Railroad last September were as follows:

1 Combination car	83,470 lbs.
1 Coach	83,700 "
1 "	82,140 "
1 Wagner car	109,000 "
Load "	2,690 "
Total weight of cars	361,000 "

The train had a seating capacity for 318 passengers, so that the weight of cars *per passenger* was 1,656 lbs. The weight of cars on the New York Elevated Railroad is 24,000 lbs., and they seat 48 passengers, or 500 lbs. per passenger. It will be seen, then, that the cars of the fast train weighed more than three times as much, in proportion to their carrying capacity, as those of the Elevated Railroad. It may be said, and it is believed to be true, that the latter could be run on any good road at the same speed as the fast train made without danger excepting in case of derailment or collision. It is not certain that the journals could be kept cool during long continuous runs, but that is not of immediate importance in our present inquiry. On English railroads six-wheeled cars, weighing very little if any more than those on the elevated road, and seating as many passengers, are constantly run at the highest speeds known in that country. It therefore may be assumed that cars of that weight may be run with safety so long as there are no mishaps, such as derailments or collisions. Now, it is not our intention of inferring hastily that the New York Elevated Railroad cars should be substituted for those which are run, for example, on the Empire Express. All that is suggested is a little reflection on the striking fact that there are cars which it would be safe to *run* (we are not talking about stopping them too suddenly now) at the highest speeds, which weigh less than a third as much as those in use. Now, why could not or should not the elevated railroad cars be used on fast express trains? Obviously for two reasons: first, they would not give the conveniences and comforts which are demanded by travellers now. The seating room, heating and lighting appliances are inadequate. In the climate of New York State double windows are needed in winter, to exclude the cold; for long runs, water-closets are essential and lavatories desirable. The absence of all these on the light cars would unfit them for fast express service. What is needed in such service is more room for passengers, which will require that the car bodies should be wider than those of the elevated cars. Upholstered seats with reversible backs are demanded for through trains. Steam heat is required by law, and gaslight, parcel racks, and ventilation the public will always demand, although they are not always provided. The essentials, conveniences and comforts of transportation with which each passenger is supplied in the elevated cars weigh 500 lbs. On the fast express, the weight of which is given, these weigh 1,656 lbs., or a difference of 1,156 lbs. The question then comes up whether the additional room which is needed, more comfortable seats, better heating and lighting appliances, water-closets, lavatories, double windows, better ventilation—in short, all that could reasonably be demanded—could not be furnished so as to weigh materially less than 1,156 lbs. per passenger. It is believed that a skilful designer of cars, by the exercise of good judgment and perhaps some ingenuity, could evolve a car which would give travellers all that they could reasonably demand with a very material reduction of weight. The following are the reasons for thinking so. The half of 1,656 lbs.—the weight per passenger of the express cars—is 828 lbs., which is 328 more than the *whole* weight per passenger of the elevated vehicle. Could not the additional conveniences which have been enumerated be supplied and not exceed in weight 328 lbs. for each person? For example, could not a 54-seat passenger car be made with all the required conveniences and comforts and not weigh over 44,712 lbs., or 828 lbs. per passenger? The weights of cars thirty or forty years ago indicate plainly that this is quite within the range of possibility. It is true that the cars of those days did not have the comforts and conveniences which cars are now expected to have, but in those days neither travellers nor car-builders knew how to be comfortable. Such a thing as an easy seat was unknown, and for ventilation we had to depend upon a few round holes in the roof, and for heat upon the mutations of a wood stove and the vagaries of a brakeman. Steel and wrought iron are now available for construction, whereas they were not "when we were boys." A degree of lightness without diminution of strength is, therefore, possible now which was not then. Of course such a car as is here contemplated would require to be designed by a master of the art. He would need to have a thorough knowledge of car construction, and also be accustomed to being comfortable and to a certain amount of luxury. There are many people who don't know how to be comfortable, or when they are so. The most important qualification for such work, though, is that mechanical instinct which is born in some persons and becomes marvellously developed by practice, experience and observation. It is a mixture of mechanical aptitude, inventive ability, good sound sense and judgment and experience in construction.

Let it be supposed that four such cars were designed and built. They would weigh 44,712 lbs. each, and their total weight would be 178,848 lbs., or less than half as much as the train which made the fast run in September, and they would seat 216 passengers. The problem of hauling a train of that weight, at 60 or 70 miles an hour, is a much easier one than to do it with more than double the load at the same speed. The weight of locomotive could also be reduced in the same proportion. Let us see how the problem would stand then:

The locomotive and tender employed on the fast run referred to weighed 204,000 lbs., making the total weight of train 565,000 lbs., or 2,591 lbs. per passenger. With our light cars and an engine of half the weight we will have 178,848 + 102,000 = 280,848, or 1,300 lbs. per passenger. Obviously it will be very much easier to make fast time with a given number of passengers if we must haul only 1,300 lbs. of dead weight for each of them than it would be if we must haul 2,591 lbs.

But the important question of safety must be considered, not alone safety while running, but, as has been said, in cases of collision and derailment. There can be no doubt of the fact that accidents now do much less injury to the occupants of cars than they did before they were made as heavy and as strong as they are now. It is conceded at once that if any diminution in weight of cars would be followed by greater risk and fatality and more injury to their occupants in case of accidents, that the reduction contemplated would have to be abandoned. Cars must be made as strong as possible to resist collisions, and the better able they are to roll down an embankment without being crushed or dismembered, the better chance the people in them have of escaping injury. It should be pointed out, perhaps, that *weight* and *strength* to resist accidents are not synonymous terms. In fact, weight is often the direct cause of injury in accidents. In case of a collision, the chances of the occupants of a New York Central coach to escape injury if the cars behind them were of the New York Elevated pattern would be better than they would be if the rear part of the train was made up of either Wagner or Pullman sleepers. It is, of course, true that if the light cars were in front their occupants would then be exposed to more danger than they would be if they were in heavy cars. All weight which does not add strength is an element of danger and not of safety in case of accident. As a matter of fact, though, it seems doubtful whether

cars generally are specially designed to resist collisions, if we except the construction of their platforms and buffing appliances; and who ever heard of any feature of car construction being adopted because it would make a car stronger to resist rolling over? If we intend to build cars with reference to collisions and rolling down embankments, let us frankly acknowledge it, and employ the very best engineering skill and knowledge to so design their frames as to have the maximum capacity to resist both kinds of accidents, and not pile up destructive weight, and excuse it on the plea that it is intended to resist such disasters. It is doubtful whether the kind of skill referred to—such as has for a long time been employed in the design of roofs and bridges—has ever been exercised in any similar way in an effort to get the maximum amount of resistance to collision and rolling in a car body. It does not seem to be chimerical to believe that if a very high order of designing skill was exercised on the problem, that as much strength in car bodies could be retained as they have now with a very material reduction in weight, and that at the same time every reasonable comfort and convenience in the cars could be provided. If such a reduction in weight was effected, it would make the problem of increased speed a much easier one than it now is.

It was intended to have something to say in this article about locomotives, but cars have occupied so much space that the discussion of the engines must be reserved for a future number.

NEW PUBLICATIONS.

THE PRACTICAL APPLICATION OF THE SLIDE VALVE AND LINK MOTION TO STATIONARY, PORTABLE, LOCOMOTIVE AND MARINE ENGINES, WITH NEW AND SIMPLE METHODS FOR PROPORTIONING THE PARTS. By William S. Auchincloss, C.E. XIII Edition Revised. New York: D. Van Nostrand Company. 138 pp., 5¼ × 9 in.

The publishers have issued the thirteenth edition of this well-known book, which they say "has been thoroughly revised by the author, and appears with many additions and improvements." The original edition first appeared more years ago than we like to recall, but our well-worn copy is dated 1869. The book, notwithstanding the fact that it has been before the public so long, still remains perhaps in many ways the best one on the subject.

The engravings—some of them—have been made over and improved, and the dust of a quarter of a century has been brushed from its pages, and the book comes to us like an old friend who has turned up again looking fresh and ruddy.

MODERN EXAMINATIONS OF STEAM ENGINEERS; OR, PRACTICAL THEORY EXPLAINED AND ILLUSTRATED. By W. H. Wakeman, Instructor in Steam Engineering at the Boardman Manual Training School, New Haven, Conn., etc. Bridgeport, Conn.: American Industrial Publishing Company. 272 pp., 5¼ × 7¼ in. $2.00.

In the sub-title of Mr. Wakeman's book it is said that it "comprises full and complete answers to 300 questions for the use of engineers and firemen when preparing to make application for examination for United States Government and State license, and for the information of engine builders, boilermakers, machinists, etc." The questions are printed in the back part of the book, and after each one the page is given on which the answer may be found.

If this book had to be described in one word, it might be said that it was "rambling." Webster's definition of "ramble" is "to talk or write in a discursive, aimless way," and discursive he defines as "passing from one thing to another," which is what the author of the book under review often does. Thus the title to Chapter III is "Directions to Those who Desire a First-Class License." It occupies nearly four pages, and begins with an explanation why only a small proportion of the licenses issued are first-class, the obvious reason being that "it is easier to get one of the lower grade." There is then an explanation of "lap," and what it is for. This is followed by a description of the ways in which different men go about learning things, with an illustration of how some men, in taking charge of an engine, will note the position and length of its eccentrics, length of its rod, etc. Lap is then taken up again, which is followed by an explanation of lead. In the last paragraph there is a description of how the connection between the crank-shaft and the valves is made. This is followed by observations on setting valves, and the chapter closes with directions for reversing an engine. There are no engravings to illustrate what the writer is explaining, which is a serious defect. A clearly drawn sectional view of a valve would have given an ignorant reader a better idea of what lap and lead are, and would have impressed it on his mind more indelibly than many pages of writing possibly can. There are, in fact, no engravings in the book excepting a few indicator and some other diagrams, which is a very great deficiency.

There are altogether 53 chapters. The first 13 treat of the engine. Then the boiler and its attachments are discussed in seven more. The operation of an engine, including the use of the indicator, consumption of water, expansion and pressure of steam condensers, steam heating, shafting and belting, boiler explosions, strength of boilers and their parts, and strength of tubes, are all discussed.

The book is written in an easy, conversational style which can readily be understood, and there is seldom any difficulty in knowing what the author means. Whether his explanations will be easily understood by those who are ignorant of the subjects about which he has written is doubtful. That they will find it a very useful book there is no doubt, as it abounds with suggestions and hints which ought, at any rate, to put its readers on the track of the information they will need to pass an examination. A candidate for a license, however, would be unwise to depend upon the fragmentary instruction contained in this book to enable him to pass an examination, as the explanations are often inadequate. Thus, on page 191, in discussing boiler explosions, it is said that "those who advocate the idea that all of the water will always flash into steam when the pressure is suddenly relieved are not wholly right, for it cannot be converted into steam unless there is heat enough stored in it to cause it to evaporate, and the necessary heat is not always present." But why don't it? Steam of 100 lbs. pressure has a temperature of 338°. If water is heated to that temperature, why will it not be converted into steam if the pressure is relieved? The candidate for a license, it is to be feared, would be left in a fog if he were questioned about this and had no other information than that which is given him in this book.

If, as may be inferred, the book was intended for uneducated readers, or those with limited amount of book knowledge, putting the rules for making calculations into algebraic formulæ is a mistake. Thus, on page 181, the following formula is given for calculating the size of crank shafts:

$$\sqrt[3]{\frac{D^2 p + d^2 15}{2468}} \times S =$$

Now, imagine a well-meaning, hard-working, faithful fireman, who is quite shaky in the three R's—particularly "rithmetic"—about to apply for an engineer's license, and encountering such a formula. His condition would be pitiful, especially as it is possible to state the rule for making such a calculation verbally and in a form which might be easily comprehensible to him. There is an ailment to which some authors of technical books seem to be subject, which may be called mathematical flatulence, which their patient readers are compelled to endure, but which is inexcusable in books intended for those with only the elements of an education.

The book before us is full of useful hints and suggestions, and doubtless those for whom it was intended will find it of considerable value and will be helped in preparing for their examinations; but it belongs to that class which make a reviewer wonder why the author, having made it as good as he has, did not make it a great deal better.

ROPE DRIVING: A TREATISE ON THE TRANSMISSION OF POWER BY MEANS OF FIBROUS ROPES. By John J. Flather, Professor of Mechanical Engineering, Purdue University. New York: John Wiley & Sons; London: Chapman & Hall. 221 pp., 5 × 7¼ in. $2 00.

The aim of the author, he says in his preface, in the preparation of this book was "to supply the existing need of a comprehensive manual of practical information concerning rope-driving and the principles upon which the practice rests." The subjects of his chapters are an historical introduction, giving an account of the early use of ropes for driving; multiple rope transmission; continuous rope or wound system; long-distance transmission; fibrous ropes; manufacture of ropes; wear of ropes; H.P. transmitted by ropes; deflection of ropes; losses in rope driving; and construction of rope pulleys.

In his treatment of the subject the author has very largely confined himself to descriptions of existing plants or "drives," as he calls them. These are illustrated by numerous engrav-

ings, but of rather a poor quality. Some of them are process reproductions, which are very bad. Still they generally serve their purpose of making the writer's meaning clear, which is their most important function.

The theoretical portion contained in Chapters VIII to XI is rather formidable looking, and some of the formulæ deduced will scare almost any one excepting a college professor. Taken altogether, though, it is probably the best book on the subject in existence. A somewhat curious fact may be noted in this, as in some other technical books, which is, that the engravings improve as the book advances—those in the back part, in this instance, being very creditable specimens of wax process work.

BOOKS RECEIVED.

TRANSACTIONS OF THE TECHNICAL SOCIETY OF THE PACIFIC COAST, January–July, 1895. 94 pp.

A TREATISE ON HYDRAULICS. By Henry T. Bovey. 337 pp. New York: John Wiley & Sons.

THE STONE INDUSTRY IN 1894. By William C. Day. 83 pp. Washington: Government Printing Office.

ELEMENTS OF DESCRIPTIVE GEOMETRY. By Charles William MacCord. 248 pp. New York: John Wiley & Sons. 248 pp.

PRAY'S STEAM TABLES AND ENGINE CONSTANTS. By Thomas Pray, Jr. 85 pp. New York: D. Van Nostrand Company.

THE PRODUCTION OF TIN IN VARIOUS PARTS OF THE WORLD. By Charles M. Rolker. 88 pp. Washington: Government Printing Office.

ENGINEERING CONTRACTS AND SPECIFICATIONS. By J. B. Johnson, C.E. 417 pp. New York: Engineering News Publishing Company.

ALTERNATING ELECTRIC CURRENTS. By Edwin J. Houston and A. E. Kennelly. 225 pp. New York: The W. J. Johnston Company.

THE PRACTICAL APPLICATION OF DYNAMO ELECTRIC MACHINERY. By Carl K. MacFadden and William D. Ray. 167 pp. Chicago: Laird & Lee.

THE PRACTICAL ENGINEER'S POCKET-BOOK AND DIARY, 1896. Edited by William H. Fowler. 371 pp. Technical Publishing Company, Limited, Manchester, England.

REPORT OF THE QUEENSLAND RAILWAY COMMISSIONER, for the Year ended on June 30, 1895. 58 pp. and map. Brisbane: By Authority, Edmund Gregory, Government Printer.

MEASURING WATER. An Address to the Students of Rensselaer Polytechnic Institute, Troy, N. Y. By Clemens Herschell. 28 pp. Reprinted by Builders' Iron Foundry, Providence, R. I.

ENGINEERING TRANSLATIONS. Comprising the Names of 1,600 Technical Parts of Boiler Engines, etc., in English and Spanish. By J. A. Standring. 69 pp. London and New York: Hirschfeld Brothers.

EIGHTH SPECIAL REPORT OF THE COMMISSIONERS OF LABOR. *The Housing of the Working People.* Prepared under the Direction of Carroll D. Wright, Commissioner of Labor. By E. R. L. Gould. 461 pp. Washington: Government Printing Office.

TRADE CATALOGUES.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. The advantages of conforming to these sizes have been recognized, not only by railroad men, but outside of railroad circles, and many engineers make a practice of immediately consigning to the waste-basket all catalogues that do not come within a very narrow margin of these standard sizes. They are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

STANDARDS.

For postal-card circulars	3¾ in. × 6¼ in.
Pamphlets and trade catalogues	3⅛ in. × 6 in.
	6 in. × 9 in.
	9 in. × 12 in.
Specifications and letter-paper	8¼ in. × 10½ in.

CROSBY STEAM GAUGE & VALVE COMPANY. This company sends two leaflets, one describing the indicator they make, and the other giving engravings and descriptions of Sargent's electrical attachment, which, it is said, is "an electrical device applicable to an indicator, by means of which any number of instruments can be operated and diagrams taken at the same instant of time."

THE PAINTING OF METALLIC SURFACES. Harrison Brothers & Co., Philadelphia. 8 pp., 6 × 8 in. [Not standard size.]

This firm, being largely engaged in manufacturing paint, have given here reasons for preferring red lead to any other pigment for painting and protecting metallic surfaces. They also make what they call "Anti-Rust," and recommend the use of red lead as a priming coat, and a second coat of "Anti-Rust."

BARRUS' UNIVERSAL STEAM CALORIMETER, 1895 PATTERN. Gowing & Co., Boston. 8 and 12 pp., 3½ × 6 in. [Standard size.]

The makers of this useful instrument have issued these two little vest-pocket volumes, which give an engraving of the calorimeter with a description, directions for attaching it, and for finding the percentage of moisture and for its general use

HEINE SAFETY BOILER COMPANY, St. Louis. 12 pp., 3½ × 6 in. [Standard size.]

The makers of this boiler here describe the reasons for the claimed superiority of their boiler, the character of their guarantee, and a copy of a letter accompanying a remittance of $1,500 premium to be paid in case certain boilers furnished exceeded their guarantee of evaporating 8 lbs. of water per pound of coal.

THE "ST. LOUIS CORLISS" ENGINE. Built exclusively by the St. Louis Iron & Machine Works, St. Louis, Mo. 10 pp., 3½ × 6½ in. [Not standard size.]

The St. Louis Company have issued a vest-pocket description of their works and engines. It contains exterior and interior views of their works, engravings of several styles of engines, and tables of sizes, etc., and ends with a list of prominent purchasers.

CORBITT & BURNHAM, of Chicago, have issued in type-written form an "argument" on "The New Time Table *vs.* The Old Time Table," and give with it a large engraving of a clock dial, one half of which is black and the other half white, representing respectively the hours of day and night. They also give specimens of the proposed time tables in which the day hours are printed in black letters on a white ground, and the night in white letters on a black ground, the purpose being to make them immediately distinguishable one from the other.

THE LIFE OF AN IRON ROOF; OR, HOW LONG WILL IT LAST? The Cincinnati Corrugating Company, Piqua, O. 12 pp., 4½ × 8 in. [Not standard size.]

That doctors disagree most of us who have had occasion to make use of their services have found out. It seems also to be true of painters. One catalogue, which has just been received, recommends red lead for metal surfaces, while the company whose publication is now before us say that experience teaches them that iron oxide or dry metallic paint reground in pure linseed-oil is the best.

In their pamphlet the corrugating company describe the different kinds of roofs which they make, and give the reasons why they think they are good. The last pages of their book contain testimonials of the superiority of their roofing.

ROBINSON RADIAL TRUCK. Souvenir American Street Railway Association. Robinson Electric Truck & Supply Company, Boston. 20 pp., 6¾ × 9½ in. [Not standard size.]

Apparently the pamphlet before us was intended for distribution at the Street Railway Association's meeting, at Montreal. The Robinson radial truck has three axles, of which the two end ones can turn on a centre pin which is not exactly in the centre of the axle. The middle axle can move laterally but not centrally, and being attached to the frames which carry the end axles, such movement has the effect of turning the two end axles about their centres and bringing them into a position radial to the curve occupied by the car. The principle and construction are shown by outline drawings, and a number of views of cars having this truck are also given.

PUNCHING AND SHEARING MACHINERY. Manufactured by the Long & Allstatter Company, Hamilton, O. Catalogue No. 18. 88 pp., 6 × 9 in. [Standard size.]

Although 80 different machines are described and illustrated in this publication, it is said in the preface that "it is not in-

tended to be complete or even descriptive in a general way, but is intended merely to furnish illustrations which will enable those interested to get an idea of the different kinds of machines we build and their construction." Even a person who tries to keep abreast of the progress and development of tools and machinery cannot help but be surprised at the extent of the adaptation and the variety of machines of this kind which are made.

The engravings in this book are the very best kind of woodcuts, most of them made by Ten Eyck, of New York, who is a veteran and a master in this kind of art. It has been remarked in these pages before that there is no method of representing machinery which equals wood-engraving when it is of the very best kind. Even photography will not equal it, because photography represents an object as it appears, or the effect of the light and shade, whereas a good wood-engraver will show a machine as we would like to see it—that is, he will bring out any parts which are obscure, and emphasize those which are relatively of the most importance. Besides Ten Eyck's work, there is some by the McFee Company, of Hamilton, O., and others by the Clegg-Goeser Company, of Cincinnati, which are also so good that it would be invidious to make comparisons. There is one piece of work on page 71 of which the name of the engraver is not given, but which is remarkable. It represents a heavy, double-geared, multiple punching machine with spacing table, designed for perforating plates by punching one complete row of holes after another, and works automatically. The machine itself is admirably engraved; but in the foreground a perforated plate is represented punched full of small square holes and standing on edge, so that it is possible to see through the holes. There are 39 holes in the vertical rows and 43 in the horizontal ones, so that there are altogether 1677 holes represented, each one so accurately cut that they will bear examination under a magnifying-glass. Nor is this all; the legs of the machine, the shadows and shading on the floor showed through these holes, the effect of which is accurately and faithfully reproduced whenever there was any of it to show. One is appalled at the labor involved in doing this, and filled with admiration for the skill displayed in producing this result.

The catalogue is in every way an admirable one. The engraving, printing and typography are all of the best and in excellent taste, and a good index adds to its merits.

THE TRAVELLING CABLEWAY AND SOME OTHER DEVICES EMPLOYED BY CONTRACTORS ON THE CHICAGO MAIN DRAINAGE CANAL. Compiled and Published by the Lidgerwood Manufacturing Company, New York, Chicago and Boston. 72 pp., $5\frac{1}{4} \times 9\frac{1}{4}$ in. [Not standard size.]

It is difficult to know whether to class this publication with "Trade Catalogues" or "New Publications," and it is another illustration of the fact that the best technical literature on some subjects is to be found among trade catalogues. The specimen before us contains first a very good general description and map of the Chicago Main Drainage Canal, with sectional views showing a cross-section of this, the Manchester, North Sea, Baltic and North Sea, Amsterdam canals, from which the reader can quickly get a general idea of the magnitude and character of this great work; and in the following pages the methods and means employed for excavating and conveying the materials from the canal are very lucidly described. The Lidgerwood cableways, conveying devices, and hoisting engines were extensively used, and it is these chiefly which are the subjects of the illustrations and descriptions. Excepting the map and a few line engravings, the illustrations are half-tone engravings made from photographs taken along the line of the canal. This in the rock cuts is a ditch 162 ft. wide, and which will have a mean depth of water of $24\frac{3}{10}$ ft., and in the earth cuts it will be over 300 ft. wide. It is estimated that nearly 40,000,000 cub. yds. of material must be excavated to complete this work, the cost of which will be $27,303,216. It was, therefore, of the utmost importance that means should by adopted for doing the work in the most economical way. The methods chiefly employed were the cableways made by the Lidgerwood Company, and inclined railroads. The former consist of a steel wire cable $2\frac{1}{4}$ in. in diameter, which is stretched transversely to the canal over the tops of two wooden towers; one of them, which is placed near to the edge of the canal, is 73 ft. high, and the other one some distance from it. The span of the cable is usually about 700 ft., so that the highest or head tower is about 500 ft. from the canal. The "spoil bank," on which is the material taken from the canal, is between this tower and the canal. A suitable carriage runs on the main cable, which carries a "skip," which is a square box or bucket 7 ft. square and 2 ft. deep, into which the material is loaded. It is suspended from the travelling carriage by suitable cables and pulleys for hoisting vertically and traversing horizontally, and also for dumping it over the bank. The power is supplied by a Lidgerwood hoisting engine, of which this company have built over 11,000. It would take too much space to describe here all the interesting features of the appliances which have been used in this great work. The book contains 40 views taken along the line of the canal. The descriptions of the appliances are models of conciseness and condensation, and are so interesting withal that the reader who is in any way concerned in engineering work of the character described is not likely to lay it down without reading the whole of it. This brochure gives an excellent idea of the magnitude of this work and of the methods adopted for doing it. While this description of it is issued for gratuitous distribution, the publishers have been extremely modest, and have not inserted any advertisement of their business other than saying that they are the manufacturers of much of the machinery described.

HEADQUARTERS FOR ENGINEERS.

To the Editor of the AMERICAN ENGINEER AND RAILROAD JOURNAL:

SIR: I was much gratified with your editorial in the November 1 issue regarding a great engineering library under the auspices jointly of the national engineering societies. This scheme, with its logical amplification of a joint house for offices, headquarter apartments, assembly halls, etc., is one that I have for several years promulgated among my friends and among the membership of the four great societies. Unfortunately, however, the world seems to be still too young in its civilization for a hearty co-operation of this kind. It cannot even see what you have so ably pointed out—the supreme folly of trying to start a number of little rival libraries—all alike, and inevitably, miserable weaklings.

Upon the occasion of the summer convention of one of the societies in this present year, the subject was discussed at considerable length before some 200 or 300 members, of whom two or three (myself among the number) said all that was possible in favor of such a project, urging the society to have it considered by special committees before going on to purchase real estate for a new house of its own.

Those of us, however, who ventured to constitute ourselves such an exceedingly small minority, found that we were like the traditional juryman who "never saw eleven such contrary men in his life" as were his colleagues, and we regretfully saw the scheme absolutely killed. The chief burden of argument on the part of the "contrary" majority was the "impossibility" of carrying out such a scheme, the difficulties being of all sorts and kinds; one of the principal ones, I believe, consisting of the alleged impracticability of arranging legal titles to ownership, etc.

The unfortunate fact is, sorry as many of us may be to acknowledge it, that the majority of engineers *do not want* to come together in this way, and until they do there is probably little use in urging it upon them. Just why they don't it is difficult to see, as such a scheme is so pre-eminently sensible and profitable to all concerned, from a business point of view, to say nothing of the additional radiance that would glorify the profession in the eyes of foreign engineers and of laymen at home by the possession of the magnificent headquarters, which might easily be arranged for were the 6,000 or 8,000 engineers and architects who are invited to join in the movement to enter into it with spirit.

The idea that rich men would not give because they would not feel sure of their money being wisely and durably expended is not worth a thought; for who doubts that a small commission of good lawyers and engineers could in a few hours formulate a scheme that would allay the fears of the most cautious of millionaires.

As things seem to be going now it will probably be some time—a good way along in the next century—before the lovely ideal that a few of us have so long cherished will become a reality. When it does, New York (unless Chicago gets ahead of her again, and takes it away from her) will see one of the most magnificent buildings in the country, with every convenience and beautiful decoration that the skill and taste of the engineering fraternity can contribute, ornamenting the best part of the city, and containing a splendid assembly hall and all other necessary apartments for its primal purposes, together with the biggest and best engineering library and museum in the world. The surplus room will be occupied not by ordinary "stores," but by offices of engineers, architects, chemists, metallurgists, etc., thus maintaining the character of the building in its full integrity. It must be remembered that a building of this sort would have extensive revenues, which would go a long way toward making it self-supporting.

It may be objected that all this will hardly come to pass after the great societies have spent so much money in buying and building individually. This need not stop the new scheme, however, for real estate can always be sold; and when our engineers shall have once attained the proper spirit of unity and harmony, together with an *esprit de corps* that shall make each one think of himself broadly as an *engineer*, and not as a civil or electrical or naval engineer merely, all that we desire shall come to pass. OBERLIN SMITH.

ALTERNATING CURRENT ELECTRIC RAILWAYS.

Editor AMERICAN ENGINEER AND RAILROAD JOURNAL:

IT has recently been given out that the Allentown & Reading Electric Railway Company intend to build somewhat extensive electric railroads in Pennsylvania and to operate the system by means of alternating currents. If these intentions of the company are carried out, this will be the first practical alternating-current road in existence, and engineers will await with interest the result.

To many engineers this step will indicate that the process of evolution in electric railroading which they have long been expecting has at last begun. It would seem to many that in this case, as in some others, inventors, in attempting to solve the problem, have hit upon a method not the best, and that subsequent inventors have for a long time followed in the original footsteps, improving, but making no radical changes for the better.

There certainly is no application of electricity in the arts to-day more eminently suited to alternating currents than is the electric railway. The problems that alternating-current railways present are surely no more difficult of solution than those presented years ago to the engineers who perfected the present system.

Almost simultaneously with the announcement of the proposed road a paper is read before the American Institute of Electrical Engineers by Mr. Charles S. Bradley on Phasing Transformers. This will undoubtedly prove of the greatest value in the ultimate solution of the problem.

A brief review of the difficulties to be encountered and the advantages to be gained by the use of alternating currents for electric railways will, perhaps, not be out of place at this time.

Considering the two systems in general, we find that the alternating system, if it can be successfully employed, offers immense advantages in simplicity and cheapness both in the original cost of apparatus and in its operation. It can also be employed with greater safety to life and property, and gives rise to no such troubles as electrolysis of water and gas pipes.

All dynamo electric machines are alike in this respect, that the currents that are generated in their armature conductors are alternating, no matter whether the machine as a whole is adapted for continuous or alternate current working. It is therefore necessary, in order to produce a machine generating continuous currents, to add a complication in the shape of a commutator for rectifying the alternating currents of the armature. Now, it is a well-known fact that the commutators of large dynamos are exceedingly difficult and expensive to construct, and in the operation of the machine it is the commutator almost exclusively that occupies the attention of the attendant. It will thus be seen that not only is the initial expense of commutating machines far in excess of alternators, but the expense of operating is also considerably greater by reason of the extra attention necessary, the frequent need of brush renewals, and because the power wasted in brush friction and drop of potential at the brush contacts may in a large station amount to a very considerable yearly item.

On the other hand, it may be urged that most of our alternating-current machines have commutators also in addition to collecting rings. That is very true, but commutators and collectors are by no means necessary in the design of a good alternator. At present most manufacturers make use of them either because they are convenient or in order to avoid conflicting with present patents. Alternating-current generators can be bought to-day of thoroughly reliable manufacturers, and be possessed not only of no commutators or moving contacts, but which have no moving wire as well. What could be more simple than a generator whose only moving part is a mass of laminated iron turning about self-oiling bearings? Such a device will evidently call for the minimum initial expenditure as well as the minimum expense of operating.

Passing from the generating plant to the feeders, we find that with the continuous current system we are not permitted to maintain a voltage much above 500 by reason of the danger to life. Were this barrier removed, we would find that it is impossible to build a successful commutating machine for high voltages. This means that for operating a large system the current is necessarily very great, and the feeders, consequently, very large. If the road is long, we are under the necessity of dividing the generating plant into sections located along the route on account of the large loss of power in long feeders. In any case, the generators must be overcompounded to a considerable degree in order to keep the voltage at the trolley reasonably constant.

In view of these considerations, we readily see: 1. An enormous outlay is necessary for copper. 2. The generating plant will be more expensive to install and operate than if it were all contained in one building. 3. The generators must be operated part of the day, at least, with a low efficiency and consequently large expense.

Granting for the moment that the system can be operated by alternating currents without altering the existing lines, we find that we immediately have an immense advantage. The gain will be threefold. The loss of power in the transmission lines and, consequently, the expense of operating may be greatly decreased. The initial expense of installing the line, and, therefore, the fixed annual charges for interest is much less. A practically uniform voltage may be maintained upon the trolley, and this can be made as small as desirable without greatly increasing the expense, either of operating or installing. All this may be accomplished with extreme simplicity.

The generators, being without commutators or sliding contacts, may be built to deliver a very high voltage, say 10,000, to the lines without danger to the attendant or apparatus. Such machines are now actually built and guaranteed by the manufacturers. With 10,000 volts instead of 500 the current necessary in order to deliver the same amount of energy to the lines will be only one-twentieth of its former amount. As the loss of power in the lines at any instant is C^2R, it is evident that by using the same set of feeders we may decrease our transmission loss by this means to one-four hundredth of its present value.

At the present time it is probably this transmission loss more than any other thing that has thus far made very long electric railways a practical impossibility. It is impossible to employ very high voltages with the continuous current system, owing to the impossibility of using commutating machines. A combination system might be employed in some cases to-day with advantage, using a high voltage alternating transmission and transforming by the use of rotary converters into a low pressure continuous current for supplying the trolley. Such a system has the disadvantage that an attendant will be required to operate each converter, it being moving machinery and constituting in effect a small sub-station. Such converters are also far more expensive to construct and operate than the stationary transformer, and it is obvious that the method is at best a makeshift, and that the pure alternating-current system will prove the ultimate method of operating such lines.

In using a pure alternating system, we must remember, however, to deduct from the apparent gain we noticed above a small amount representing the losses in the necessary transformers, because in this case, as well as in the use of continuous currents, a high voltage in the trolley is not permissible. It should also be mentioned that if the road is very long the transformers along it can be wound in a progressively changing ratio which will compensate for the drop of potential in the primary mains, and keep a practically uniform pressure on the trolley from end to end of the route.

But we have yet to prove that the present lines *can* be employed for operating a pure alternating current system, for, as yet, nothing has been said concerning the car equipment. That is the only difficult feature of the problem as it stands to-day, and engineers have long been familiar with the considerations outlined above. It is in the motor, however, that the alternating system *should* especially outclass its rival, and it is the motor that has thus far given the greatest trouble to electric railroad men.

The alternating current motor of to-day is unsuited for railroad purposes for two reasons. First, it is not very efficient unless running at constant speed. Second, it is not self-starting unless wound for two or more phases, which would necessitate, for railroad use, the employment of at least two trolley wires. This can hardly be allowed except for conduit roads. Otherwise, the alternating motor fulfils to a nicety every requirement of a perfect railway motor. It has no commutator or brushes, and nothing to replace or get out of order. Its armature, being simply a mass of iron and copper with no insulation whatever, has nothing to burn out. If properly built, it is capable of running perfectly, if need be, under water, and perhaps most important of all, it is universally acknowledged to be the cheapest and most reliable motor that can be produced.

Neither of the objections mentioned seem serious, and un-

doubtedly will be perfectly removed before long. For instance, it seems to the writer that the first can be satisfactorily met by the use of some form of flexible gearing, such as hydraulic gearing. This will allow the motor to run at all times at a constant speed and high efficiency, even if the car is standing still. These devices have been described in the technical journals, so that it will not be necessary to discuss them here. The necessity of employing such a system is not an objection, for some of them offer actual positive advantages over the rigidly connected motor. A solution of the second difficulty could probably be found in the use of "phasing transformers" placed upon the car, using perhaps the form described by Mr. Bradley in his paper mentioned at the beginning of this article. By this means the single-phase current from the trolley can be converted into a three-phase current, and an ordinary three-phase motor be made use of.

Other systems could undoubtedly be arranged with the apparatus we have at hand, and many unperfected forms are in the minds of engineers to-day. The writer himself can even imagine a road employing no trolley connections whatever, but making use of some of the many effects of induction which alternating currents give us.

Thus we have an alternating-current railway that could be operated to-day perfectly upon the tracks of the present companies with no change outside the power station except the installation of a few transformers and the more careful insulation of the line. The system may not be the best, or even practicable, but is perfectly possible if occasion required it. The next few years will undoubtedly develop changes and perfections in alternating apparatus that will make the alternating-current railway all that could be desired.

ARTHUR J. FARNSWORTH, S.B.

MINIATURE WAR VESSELS.

A WARSHIP in miniature is being built at the Washington Navy Yard. Though only 5 ft. long, it is a perfect likeness of the *Columbia*, Uncle Sam's fighting ocean greyhound. Every detail is reproduced with the utmost accuracy on a scale of a quarter of an inch to the foot, even the guns being perfect in all of their parts, down to the very breech mechanism.

In the new navy of the United States several classes of vessels are comprised. The Government has adopted the policy of constructing one small model to represent each type of warship in the service. Thus miniature copies have been made of the armored battleship *Texas*, the monitor *Miantonomoh*, the ram *Katahdin*, and others. Seven men at the Washington Navy Yard are constantly employed in building these models, which cost from $2,000 to $8,000 apiece. These artisans are mechanics of the highest skill, and the work they do is such as to require a special training. Workmanship of the utmost difficulty is needed, many of the parts being so little that an ordinary person could not handle them or put them together. Everything must be reproduced, down to the smallest block for the running rigging.

Take the guns of the miniature *Columbia*, for example. They are the prettiest toys imaginable. The big ones, representing originals of 8-in. calibre, are about 4 in. long. No part of either gun or carriage is lacking, and the breech can be opened by a touch of the finger to admit a small-sized armor-piercing projectile or an explosive shell. The secondary batteries of the *Columbia* consist of a number of small machine guns and rapid-fire guns, some of which are aloft in the military tops. Every one is reproduced on its scale in the model.

The building of the model of the *Columbia* was begun by taking a number of pine boards, cut roughly to the outlines of the ship, and putting them together under pressure with glue between them. Thus a solid block of approximate dimensions was formed. The block was then planed and chiselled until the lines of the great war vessel were reproduced with absolute exactness. The hull being made smooth with sandpaper, the rudder and propeller shafts, of cherry wood, were added. At the same time were put on the "sponsons," out of which the guns look as from windows of steel. Holes having been bored for the window ports, the little craft was ready to receive its armament.

The model is not yet finished, but the guns are made and nearly all of the other equipments are ready to be put aboard. These latter are very elaborate, and to produce them has required an immense amount of labor. For example, there are a number of boats, including one steam launch in miniature. Each of these represents three days' work for one man. The false bottoms and every rib inside of them are shown. All of them are of wood, save for the smokestack and rudder of the steam launch. The boats are swung from davits, the tiny metal blocks through which the tackle runs being perfectly practical and just like real ones.

The smokestack of the miniature *Columbia* is of brass, painted just like that of the cruiser herself. Attached to it are escape pipes of copper and a whistle and fog horn, otherwise known as a "steam siren," of nickel silver. The ventilators are of copper. They turn their gaping mouths to the wind, which blows down into them and keeps the air fresh below. One of the last things done is to put the masts into the little ship. They are of wood, but, being painted, they look just like the hollow steel masts of a war vessel. The bigger spars on a war ship are steel tubes. The rigging of the model is of white wire twisted to imitate the wire rigging on a man-o'-war. In the model of a battleship the armor is represented by wood painted.

The models of warships are built in what is called the ship house at the Navy Yard. The establishment is a huge machine shop, under the control of the Construction Bureau of the Navy Department. The miniature vessels are made from the original plans and drawings for cruisers and battleships, which are reduced to scale for the purpose. The object of building the models is to show the people what Uncle Sam's new navy is like. Several of the models have been sent to Atlanta, where they will be viewed by millions. Occasionally models have been sent by the Navy Department to the capitol, in order that congressmen might see them and know what sort of ships they were appropriating money to construct.

In the ship house at the Washington Navy Yard is now being made a model of the battleship *Indiana*, 20 ft. long. It is intended, not for exhibition, but for a more practical purpose. It is of wood, covered with an even coat of paraffine 1 in. thick. When it is finished it will be run on the Potomac River, with an engine inside of it and paddle-wheels. Paddle-wheels are preferred to a propeller, because the power exerted by them can be measured more accurately. This is exactly what is desired to be ascertained—namely, how much power is required to propel the model through the water at a given rate of speed. What is true of the model ought to be true also of the *Indiana*, the form of the hull of the latter being the same. Paraffine is employed because it is perfectly smooth, and will afford no such resistance as might impair the accuracy of the data obtained by the experiments.

In Great Britain the keel of no new ship of war is laid until trial has been made of a miniature model. For this purpose is used an immense tank, 300 ft. long, 25 ft. wide, and 10 ft. deep, filled with water. Above the tank, and running its entire length, is suspended a platform. On the platform is a track, and along the track a carriage runs. Beneath the carriage floats the model, which is made wholly of paraffine. Of course, paraffine is lighter than water. The carriage tows the model along, and the power used is registered with absolute accuracy by a dynamometer. Thus is learned with exactness the speed at which the war ship represented by the model will steam with a given H.P.

Great Britain, in fact, has several such tanks, and similar ones are used for the purpose by France, Germany, and Italy. Secretary Herbert will try to persuade the next Congress to appropriate money for building a tank of the kind at Washington. The cost of it would be about $150,000. It would be cheap at the price, however, for it would afford a means of testing all models of proposed vessels in future before the contracts for their construction were given out. Thus the Navy Department would know exactly what might be expected of every warship before its keel was laid. In a word, the tank experiments make it easy to determine the best form of ship to attain a certain speed.—*Washington Evening Star.*

Our Sea-Coast Defenceless.—Major-General Miles, commanding the Army, in his annual report says: "The entire Gulf Coast and all the great cities of the Atlantic Coast northward to Philadelphia are entirely without modern guns. With one exception the cities north of New York are in a similar condition to those south of it. Some guns and mortars have been constructed and some shipped to their destination, carriages for them are under construction, and emplacements have been made to a limited extent." He shows that torpedo plants are useless without protective batteries, and that the water in our principal harbors is so deep that light-draft vessels might pass over the torpedo mines without danger.

He says that the recent manœuvres in England have shown that even the powerful British navy is unable to defend the British coast against a foreign fleet; therefore he argues that the main reliance must be upon coast batteries. He wants more high-power guns and a much higher-power "appropriation."

THE MOST ADVANTAGEOUS DIMENSIONS FOR LOCOMOTIVE EXHAUST-PIPES AND SMOKE-STACKS.*

By Inspector Troske.

Prüsmann: A later experimenter in this matter, Prüsmann, the inventor of the conical smoke-stack that has been named after him, must be mentioned. He began his experiments about the end of the year 1860, which was at about the same time as those conducted by Nozo and Geoffroy, but he went into the work so extensively, that they were not completed until the beginning of 1863. His paper was published in *Organ für die Fortschritte des Eisenbahnwesens* in 1865, and in the same year it also appeared in book form, where he gathered together his extensive results that had been reached with so much labor.

In figs. 4, 5, and 8 the experimental apparatus that was used by Prüsmann is shown. Fig. 4 shows the first arrangement that was used. It consists of a cylindrical box only 3.28 in. in diameter, through whose cover the cylindrical stacks having the same outside but varying inside diameters could be slipped, and then held in any desired position by a set screw. The blast-pipe entered through the bottom, and was connected with the boiler by means of a pipe in which a cut-off cock was placed. The opening of this cock could be made anything that was desired by means of a handle fastened to its square stem and moving over a graduated arc, thus permitting of an exact regulation of the blast-pipe pressure. Directly over the bottom of the box, as shown at the left, in fig. 4, there was an opening 1½ in. in diameter, through which the air was drawn in by the suction created in the interior. The vacuum was measured by a water column in the form of a siphon-shaped glass tube, whose connection with the box was packed with a rubber washer, the exact blast-pipe pressure not being obtained, but merely that existing in the boiler, while the experiments were in progress, which was read on a metallic pressure gauge. In his experiments Prüsmann chose only such openings of the cock on the apparatus as would produce a vacuum equal to that prevailing at that time in the current practice on the locomotives of the Hanoverian State Railway—namely, from 6 to 7 in., which was obtained by placing a stack on the experimental apparatus corresponding to that in use upon these locomotives. The nozzle of the blast-pipe had a clear diameter of .32 in., and the seven cylindrical experimental stacks had diameters of about 1.25 in., 1.33 in., 1.5 in., 1.58 in., 2.125 in., 1.7 in., and 1.77 in.

Prüsmann formulated the following conclusions as the result of his experiments:

1. The blast-pipe pressure within the limits of current practice has no influence in determining the proper shape of the stack.

2. The increase of the distance from the bottom of the stack to the top of the blast nozzle is not exactly an equivalent, but as it is increased, of course within certain limits, it is accompanied by a corresponding increase in the height of the vacuum.

3. Of the seven experimental stacks used, the one of the mean diameter of 1.58 in. showed the best results.

4. With a stack of the most efficient diameter, its height should be so adjusted that it stands at least four times the diameter of the blast-pipe above it, in order that this latter may be at a proper distance from the lower end of the stack.

5. For every height above the blast nozzle there is one cross-section of stack that will give the most efficient working.

In order to investigate these latter results which he had obtained, Prüsmann changed his experimental apparatus so that he replaced the solid cover by a movable, open shell, like that shown in fig. 5, that could be fastened in position, and on the upper end of which plates having circular openings of different sizes could be bolted. The diameter of the openings in these plates varied by ⅛ in. from 1 in. to 2¼ in. By changing the shell the 11 plates were set at a greater and greater distance from the blast pipe, varying from 0 to 7.6 in., and in this way the vacuum was measured for 39 different positions. Prüsmann thus obtained 11 series of results with 39 figures in each, which he put together in the form of a table, and in such a way that for each of the 39 positions of the blast-pipe the 11 different vacuums that were obtained formed a horizontal series. In each of the vertical as well as the horizontal series there was one of the highest efficiency.

He drew therefrom the following conclusions:

6. For each diameter of opening in the plates there is one distance from the blast-pipe that gives the highest vacuum.

7. The proper form of stack is not a cylinder, but a pipe whose diameter varies with the distance from the blast-pipe.

Now when Prüsmann had laid out the blast-pipe distances already mentioned upon a vertical axis, and had then drawn parallel lines through these points, he then laid out upon each side of the vertical the radius of that plate opening which, for the corresponding distance from the blast-pipe, gave the highest vacuum, and thus obtained a series of circular sections, as indicated in fig. 6, that outlined the general average form of a cone, and from which the conical form of stack was deduced.

Prüsmann made a stack of this shape out of tin, placed it upon the apparatus, and ascertained, by very careful adjustments, that distance of the lower end of the same from the blast-pipe where the highest vacuum was obtained. He then experimented with several tin stacks of similar shape, and finally developed that shown in fig. 7 as being the form that showed the highest efficiency.

It is worthy of note that a cylindrical section was located in the narrowest portion for the sake of avoiding the sharp angle that would otherwise exist between the top and bottom parts, and thus avoid a too rapid widening above and below.

Fig. 4.

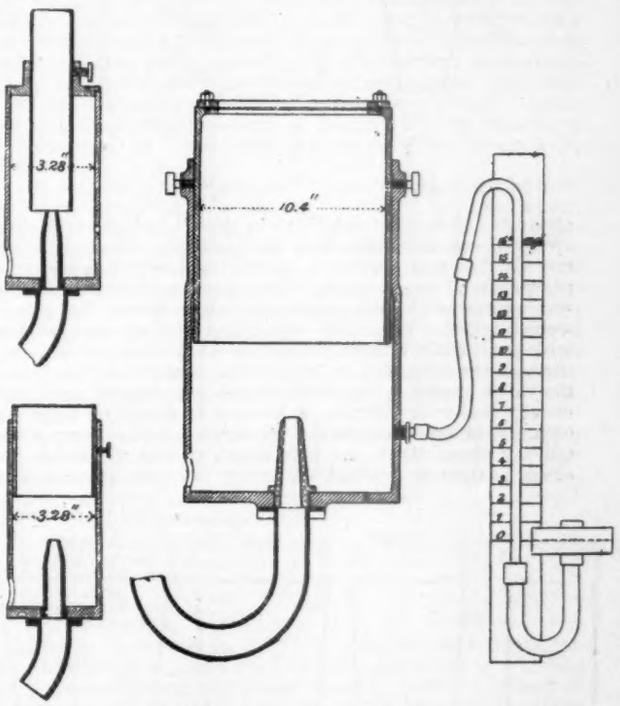


Fig. 5. Fig. 8.

Prüsmann then made a stack for a locomotive of exactly this shape, with dimensions proportioned in the ratio of the blast-pipe dimensions of the locomotive to those of the experimental apparatus, which was $\frac{2.79 \text{ in.}}{0.32 \text{ in.}} = 8.594$. The most contracted portion of this stack had a diameter of 11 in., and stood at a height of 27 in. above the top of the nozzle. The locomotive upon which it was placed, and which had formerly made sufficient steam to do its work with a cylindrical stack having a diameter of 15 in., was now found to act in such a way that the exhaust nozzle could be opened .28 in., and an average saving of 23.81 per cent. in the consumption of coal effected, which in some cases arose to as much as 42.2 per cent. On a second locomotive, which had a blast nozzle of about 42.2 per cent. greater diameter, or of 3⅜ in. diameter, and a conical stack of correspondingly larger dimensions, or $\frac{3.375}{0.32} = 10.547$ times larger than those given in fig. 7, the experiment was a complete failure. "The production of steam was often insufficient, and the coal consumption for the same loads was even increased." From this Prüsmann concluded

* Paper read before the German Society of Mechanical Engineers.

that his method of treatment was a wrong one, in increasing the dimensions of his experimental apparatus in a direct ratio, for it appeared that in the case of the 42.2 per cent. increase in the size of the blast-pipe he had taken it for granted that the grate area had been increased in the same proportion. In order to obtain information upon this point, Prüsmann built a third and larger apparatus. Fig. 8 illustrates this on a scale of one-tenth its actual size. The larger scale, which was attached to the water-gauge, enables more accurate readings to be taken than were possible with the siphon gauge. This third apparatus varies from the two others and also from the

Fig. 6.

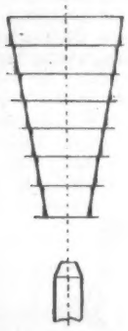
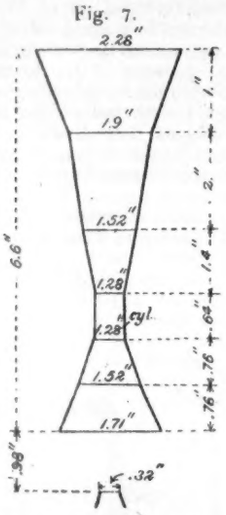
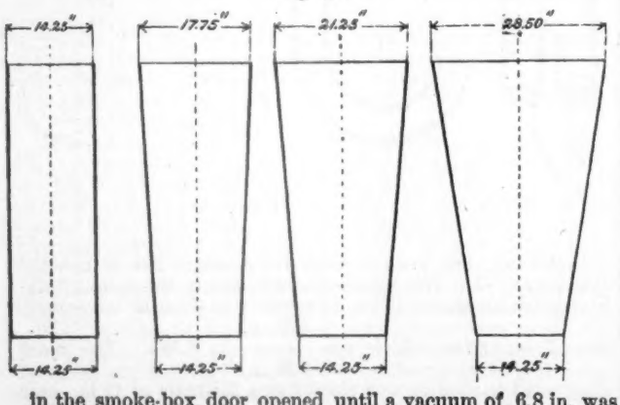


Fig. 7.



apparatus of Zeuner and Nozo in that it had three openings arranged concentrically with the blast-pipe, through which the air that was drawn in entered, and which favored the production of the vacuum. The size of these three openings was ascertained from a locomotive whose wheels and pistons were blocked. The valve was raised and so arranged that with the throttle wide open only so much steam could escape through the blast-pipe by way of the contracted openings in the valve passages, that with the ash-pan damper open, as it usually was while running, a vacuum of 6.8 in. of water was obtained in the smoke-box. Then the ash-pan damper was quickly closed tight, the tube openings into the smoke-box closed as tight as possible with sheet iron, and an air damper

Fig. 9.



in the smoke-box door opened until a vacuum of 6.8 in. was again obtained in the smoke-box. This gave, for coal and coke burning, a free opening equal to the total grate area divided by 21. This ratio was incorporated in the apparatus, and a series of experiments made which also included the use of a nozzle of $\frac{1}{4}$ in. and one of 1 in. in diameter, with which the height of the stack opening above the same varied from $4\frac{1}{4}$ in. to 25 in. The results obtained were again tested in part with the small experimental stacks, and led to the following conclusions:

8. Making the conicity of the blast-pipe more blunt has a tendency to lower the stack, but, on the other hand, the conicity of the blast-pipe is without any influence upon the distance of the smallest portion of the stack above the nozzle, or upon the diameter of that portion.

9. Under the same circumstances the taper of the shells of stacks remain nearly the same for all locomotives in similar service, provided only that the ratio of the cross-section of the blast-pipe to the grate area remains the same.

10. A stack made for a given blast-pipe must, if all the other ratios remain the same, be enlarged over all by about the difference in the blast-pipe diameters, if we wish to use a larger blast-pipe with this same taper.

11. On non condensing locomotives, whereon it is desired to increase the diameter of the blast-pipe, if the blast-pipe pressure remains the same, the distance of the smallest portion of the stack from the top of the nozzle will be unchanged.

12. The upper portion of the smoke-stack lying above the smallest portion of the same does not consist of a single truncated cone, but of three truncated cones of different inclinations; these inclinations becoming greater toward the top.

Finally, Prüsmann gave a number of formulæ for calculating the dimensions of stacks and blast-pipes. The one for the location of the blast nozzle taken as t for all locomotives is:

$$t = 2.3673 + 0.857{,}047{,}767\ \delta - 0.136{,}138{,}202\ \delta^2 + 0.525{,}258{,}551\ \delta^3,$$

wherein δ is the diameter of the blast nozzle in inches.

It may, however, be remarked that, though these experiments were carried out so thoroughly and with so much trouble, for in all Prüsmann used 18 different stacks on his apparatus, two of which were similar to those used upon locomotives, and 26 different plate openings, they are not entirely free from objections. Next the dimensions of the experimental apparatus were altogether too small, while the method of measuring the steam pressure was defective. In the first place, the boiler pressure should not have been measured, since it is always liable to a continual shrinkage; secondly, the boiler used had to supply steam for the shop engine of the works, and then these measurements should not have been taken with a metallic gauge, since it was evidently far from being sensitive enough for a current of steam flowing through an opening of 0.3 in. A quicksilver gauge should have been used in this place, by means of which an accurate measurement could have been made of the pressure existing between the blast nozzle and the controlling cock. By moving the long handle attached to the cock, it would have been easy to have held this pressure at one point. It is to the imperfection of these measurements that we must ascribe the fact that, from the various tables of figures given by Prüsmann, no accurate diagram of exactly what took place can be reproduced; for if we make a graphic delineation of the values given for a series of experiments, we get in most cases not a regular curve, but a broken line, between whose several parts there are wide variations of direction, and this is especially the case if we refer to Tables I, III, V, XII, and XVII of Prüsmann's work. In the last-named table there are, in several instances, two different values for the vacuum produced by the same position of nozzle, which is evidently impossible if the steam pressure remains the same; but before all others in inaccuracy is the statement that that plate opening which with a given position of the nozzle gave the best vacuum is the most efficient. This is seen, as a glance at the table teaches, in that the shortest distance is an accompaniment of the smallest opening, while the greatest distance between nozzle and plate is the one belonging to the next to the smallest opening. From which the stack indicated therefrom would evidently be too small. With the stack thus obtained Prüsmann experimented still further, and deduced therefrom each location of blast nozzle from the smallest section of stack under consideration, at which the highest vacuum could be produced. This distance he now took as that at which the highest efficiency could be obtained, and transferred it into terms of the ratio of the diameters of exhaust nozzles upon locomotives; but such a performance is not at all permissible, as the Hanover experiments clearly show, for these nozzle distances having the strongest action comes out many times as great on many locomotives. If we were to make an application of the Prüsmann formulæ given above to exhaust nozzles of 4 in. or 5 in. in diameter, the distance of these nozzles from the smallest section of the stack would, according to Prüsmann, be 37.8 in. for the first and 70 in. for the second, values that are unheard of in practice. That the Prüsmann stack is above all things too small has long been known. Grove speaks of this in his well-known "Theory of the Blast-Pipe" (1874), and frankly discusses the reason therefor in "The Impossibility of Establishing the Shape of the Stack by Means of the Passage of a Current of Steam through Openings in Thin Plates;" but, as we have stated above, this is not the principal reason for objecting to the results given.

There are, however, some results which Prüsmann obtained from his experiments, inaccurate as they were in part and

inapplicable as they are to the practice of the present day, which are full of significance for all time, and among them are those that led to the construction and development of the conical stack, which by varying its height above the nozzle within certain limits produces the best vacuum.

Zeuner: A very interesting continuation of the experiments of Prüsmann was commenced a year later by Zeuner, and published in 1871 under the title of "On the Action of the Blast Apparatus of Locomotives with Conical Flaring Stacks."

Unfortunately Zeuner had, as he says in writing of this work, no knowledge of the results which the Prüsmann experiments had yielded, so that he turned to his earlier experiments with cylindrical stacks that were briefly outlined in our last issue, but in other respects the information elicited was that resulting from a purely mathematical calculation. In consequence thereof his theory included not the conical stack, but the location of the blast nozzle and its influence upon the action of the draft; the length of the stack is also disregarded. He laid down the following principles:

1. For a given diameter of blast-pipe and sectional area through the tubes, there is one most efficient sectional area of stack, measured at the smallest point, with which the maximum draft can be obtained.

2. The vacuum in the smoke-box and the inrush of the mixture of air and gases increases as the flare on the upper end of the stack is increased, but a moderate amount of this flare soon gives an action that is perfectly satisfactory.

The conical stack will admit, for the same draft action, of a large exhaust nozzle opening. For the same train speed, therefore, it gives more power to the locomotive than the cylindrical stack, on account of the decrease of back pressure upon the pistons, which thus increases its mean effective working and lessens the fuel consumption in consequence.

In its general significance, conclusion No. 1 is not applicable to locomotives; the same thing may be said here that was remarked above relative to cylindrical stacks.

The results of the Hanover experiments are also at variance with the statement of No. 2. Zeuner reconciled his theories offhand by taking a blast nozzle 3.94 in. in diameter, a cylindrical stack of 14.25 in. diameter with three conical stacks, as shown in fig. 9, all of whose smallest diameters were also 14.25 in., while the upper diameters were 17.75 in., 21.25 in., and 28.5 in. He then calculated that the stack with the widest flare—that is, the one with the upper diameter of 28.5 in.—would draw in the most air with a given amount of steam, the blast nozzle remaining the same, and that it is also the most efficient.

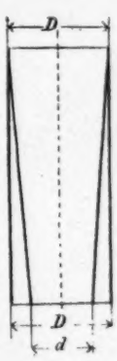


Fig. 10.

Fig. 11.

The Hanover experiments, on the other hand, showed that if the upper diameter of all stacks is kept the same, while the lower diameter is varied, the strongest draft and consequently the greatest inflow of air will be obtained with that having the smallest diameter. If we start, as Zeuner did, with equal lower diameters, we find from Tables X and XII, that give a graphical representation of the Hanover experiments, the very reverse to be the case to what Zeuner theoretically maintained.

The third of the Zeuner conclusions that we mentioned above is also not in accord with more recent experiments, for, as I shall show later on, the conical stacks are not superior to the straight stacks in inducing draft. Both forms, if properly proportioned, therefore admit of the use of the same diameter of blast-pipe for the production of the same vacuum.

Grove: We come now to the mention of Grove as the last to pursue this line of investigation. In a handbook compiled by Heusinger von Waldegg on special railroad technical work, he has handled the difficult question of the blast-pipe in a very lucid manner, has advanced some excellent theories, especially with reference to the position of the blast nozzle with reference both to cylindrical and conical stacks. His formulæ are especially valuable for locomotives with small grate areas, but for those having larger areas the calculated dimensions are too small.

In his theory Grove followed in the footsteps of Zeuner relative to the action of the draft, and also advocated the superiority of the conical stack. In paragraph X, that has been already referred to, this comparison is pointed out offhand, and that in connection with the sectional area of the tubes and not with the grate area, whereby the error is called forth. The tradition regarding the superiority of the conical stack is referable to Prüsmann. He compared a cylindrical stack, which was evidently too large with reference to the blast nozzle, as shown in fig. 11, with a conical one whose dimensions were too small. The former had a diameter of 15 in., and the latter was 11 in. at the waist. The result was that, with the first, the blast nozzle was flush with the bottom of the stack, while, with the conical stack, it was placed 27 in. below that point. Had Prüsmann contracted the cylindrical stack correspondingly and then lowered the blast-pipe, he would doubtless have obtained the same improvement in the action of the draft on his locomotive as he did obtain by the application of his small conical stack.

This demonstration of the equality of the two forms of stacks is one of the important achievements of the Hanover experiments.

(TO BE CONTINUED.)

THE UNITED STATES BATTLESHIP "INDIANA."

THE *Indiana*, one of the three coast-line battleships authorized by the act of Congress approved June 30, 1890, making an appropriation for the construction of three battleships at an individual cost not to exceed $4,000,000, has just been accepted by the Government and placed in commission. The contract for the construction of this vessel was awarded to the William Cramp & Sons Ship & Engine-Building Works, of Philadelphia, Pa. The vessel was launched on February 28, 1893.

The *Indiana* is built of steel. The hull is protected by belts of heavy armor 7½ ft. wide, 3 ft. of which is above water. This protection runs along both sides of the vessel for a distance of 148 ft. amidships, at the extremities of which the armor turns in toward the centre line at an angle of 45° for a longitudinal distance of 24 ft., affording a total broadside protection of 196 ft., and passing around and supporting the armor for the 13-in. gun turrets. On top of this side armor is placed a steel deck 2¾ in. thick, under which are the magazines and machinery. Above this belt of side armor, and extending from redoubt to redoubt, the sides are 5 in. thick with a backing of 10 ft. of coal.

The vessel is cut up forward beneath the water-line, making a powerful ram bow, and doing away with excessive bow waves on account of the easier lines so obtained as well as greatly adding to the manœuvring qualities.

The principal dimensions are:

Length on the water line	348 ft.
Breadth, extreme	69¼ ft.
Draft forward and aft	24 ft.
Displacement	10,288 tons.
Sustained sea-speed	15 knots.
Normal coal supply	400 tons.

Between the turrets for the 13-in. guns there is a superstructure in which are placed the 6-in. guns, and above or upon the deck erected thereon are placed the 8-in. guns. A battery of 6-pdrs. is arranged along the top of the hammock berthing and bridge, and 1-pdrs. are placed two forward and two aft, one on either side on the berth-deck. In the tops of the double-topped military mast are placed four Gatling guns, two in each top.

The main battery consists of four 13 in. breech-loading rifles, eight 8-in. breech-loading rifles and four 6-in. breech-loading rifles. In the secondary battery there are twenty 6-pdr. rapid-fire guns, four 1-pdr. rapid-fire guns and four Gatling guns.

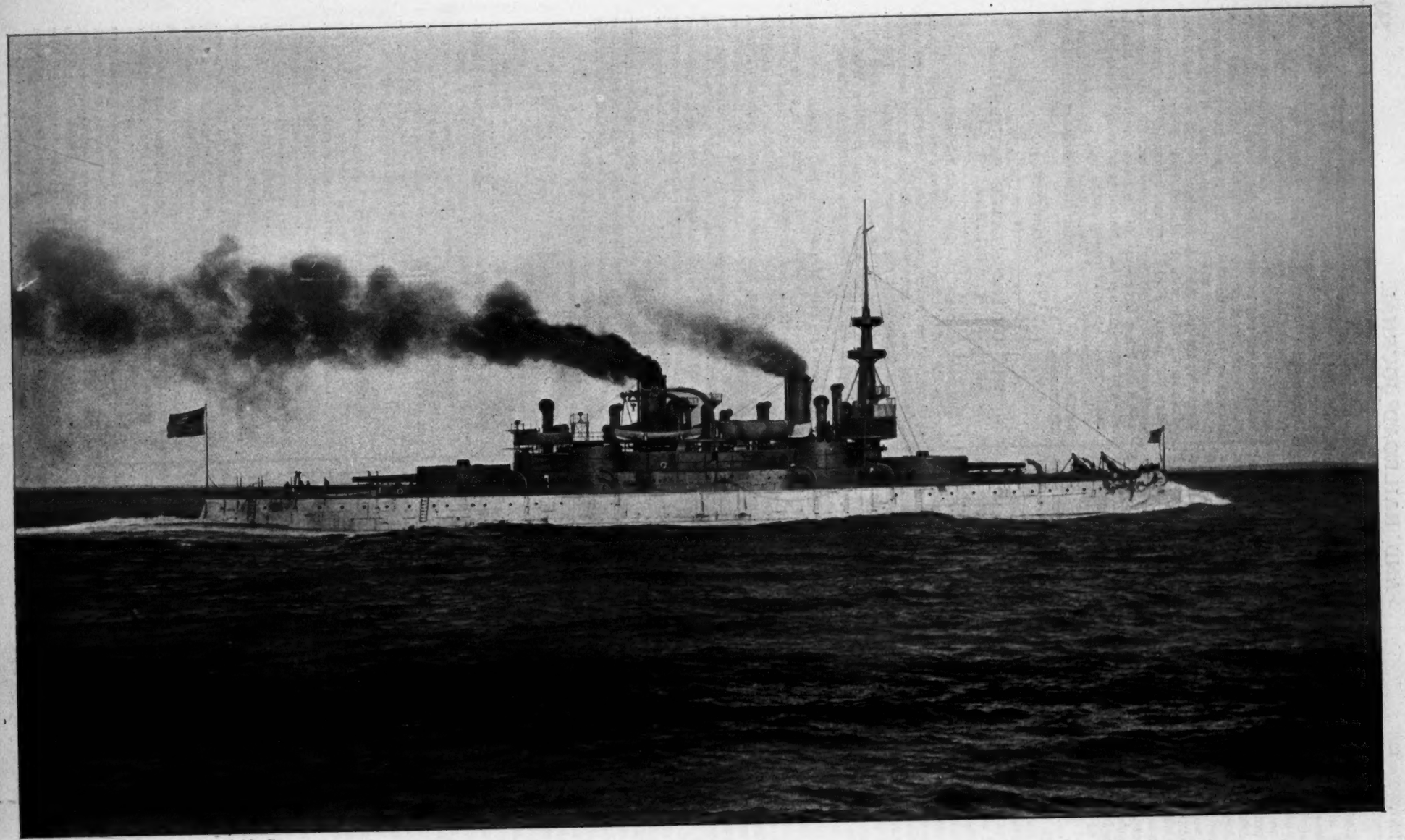
In addition to the foregoing offensive phase of the ship, there are six torpedo-tubes, one bow, one stern, and four broadside, two on either side, just abaft and forward of the forward and after barbettes respectively.

The four 13-in. guns are mounted in pairs in two barbette turrets forward and abaft the superstructure on the main deck. The lower part of these turrets, called the barbette, is 17 in. thick, while the turret proper, which rises above this wall of armor, is 15 in. thick.

The 8-in. guns are mounted in pairs in four turrets of similar character, two on either side, on the forward and after extremities of the superstructure deck.

The four 6-in. guns, two on each side, are placed amidships on the main deck. These guns will have local protection in addition to splinter bulkheads, shields and automatic shutters.

The 13-in. guns have an effective arc of fire of 270°. These guns are mounted about 17½ ft. above the water-line. The 8-in. guns are about 25 ft. above the water-line, and are high



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THE UNITED STATES BATTLESHIP "INDIANA," WHILE UNDERGOING THE OFFICIAL SPEED TRIAL OFF CAPE ANN, MASS.

enough to fire over the 13-in. turrets. These guns have a radius of action of 164°.

The engines are of the twin-screw, vertical, triple-expansion, inverted-cylinder type; diameter of cylinders being as follows: high pressure, 34.5 in.; intermediate pressure, 48 in.; low pressure, 75 in., with a common stroke of 42 in. There are four double-ended boilers 18 ft. × 15 ft. in diameter, and two single ended boilers (donkey), 8½ ft. × 10 ft. in diameter. Each boiler and engine is in a separate watertight compartment, in order to localize possible injury.

While the normal coal supply is 400 tons, there is a coal bunker capacity of 1,800 tons.

The complement will consist of 475 persons—officers and men. Good quarters and accommodations have been provided, and all the latest sanitary improvements will be installed to insure efficiency and thoroughness in lighting, ventilating, and draining.

While the *Indiana* was under construction there were innumerable croakers who were ready with all sorts of predictions that the vessel would be so top-heavy that her roll in a seaway would be excessive and dangerous. Great interest was accordingly manifested in her performance on her first trip to sea. On leaving the yard the first run was made to the Delaware Breakwater, where she anchored for the night, to wait for a heavy northeasterly gale to subside. The following morning the vessel put to sea, where, although the gale had abated, there was still a heavy sea running, and all on board were in expectation of being badly pitched and rolled about. Some of the members of the Naval Trial Board got out their instruments for registering the roll of a ship, and were prepared to note the number of degrees. To their surprise the ship rode each wave lightly, and the greatest roll noted and reported was only 1½°.

On October 16 the vessel made a preliminary run over the official course off Cape Ann, Mass., and made an average speed of 15.31 knots over a distance of 62 nautical miles. On this run the absence of the usual vibrations made by the powerful engines of a big ship were particularly noticeable. Another feature was the bow wave cast off by the ship. The torpedo-tube in the bow threw up quite a wave, but the bow of the boat itself cleft cleanly through the water, and the lateral waves, instead of extending many feet on each side of the ship, did not extend much more than 15 ft., and then they converged sharply and clung to the vessel's side, leaving no side wave at all.

The official trial was made on October 18 between Cape Ann and Boone Island. The run to Boone Island was made against the tide in 2 hours 2 minutes and 7 seconds, with an average speed of 15.24 knots. On the return the passage was made in 1 hour 55 minutes and 35 seconds, making a total of 3 hours 58 minutes and 28 seconds for the whole run, or an average speed of 15.61 knots, which was .61 knot above the contract requirements. There was a remarkable burst of speed at the latter end of the run, where a speed of 16.3 knots was attained. At this time 11,800 H.P. were developed. The average H.P. shown during the trial was 9,700, which is 700 more than the contract requirements. The maximum revolutions of the screws were 131, and the average revolutions were between 128 and 130. The average steam pressure at the boilers was 165 and at the engines 161. The average water pressure in the fire-rooms was 1 in. and the average temperature was 105.°

After the run was over a helm test was made. The ship was turned in a circle of 400 yds., or 200 less than it took to turn the cruiser *New York*, and she answered her helm with great promptness.

There are some marked peculiarities in the construction of the engines of this vessel, and in a future issue we expect to publish a very fully illustrated description of them.

MEETING OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

THE third general meeting of this Society was held in the rooms of the Society of Mechanical Engineers, No. 12 West Thirty-first Street, New York, on November 7 and 8. Papers were presented on the following subjects: American Maritime Development, by Captain Henry C. Taylor, President of the Naval War College; Performance of the Twin-Screw Steamer *City of Lowell*, by Professor J. E. Denton; Aluminum: Its Alloys, and their Use in Ship Construction, by James C. McGuire; Rudder Experiments—U.S.S. *Monterey*, by Elliot Snow, Assistant Naval Constructor U. S. Navy; Methods and Forms for Certain Ship Calculations, by D. W. Taylor, Naval Constructor U. S. Navy; The Number of Longitudinal Intervals in Ship Computation, as Affecting the Accuracy of Integration for Displacement, by W. F. Durand; Recent Designs for Vessels of the U. S. Navy, by Philip Hichborn, Chief Constructor U. S. Navy; Tactical Considerations Involved in Warship Design, by Lieutenant A. P. Niblack, U. S. Navy; The Centre Board: Its Influence on Design; its Value and its Proper Use, by W. P. Stephens; Engineering Research in the Navy, by Professor William S. Aldrich; Ventilation of Ships, by F. B. Dowst; and An Experimental Test of the Armored Side of U.S.S. *Iowa*, by Albert W. Stahl, Naval Constructor U. S. Navy.

A somewhat interesting episode occurred during the proceedings. In the discussion of Captain Taylor's paper, Rear-Admiral Richard W. Meade (retired) was brought to his feet. He wanted the Society to petition Congress at once to do something for the Nicaragua Canal. That canal was bound to be built, and this country could not contemplate unmoved any possibility of its construction by foreigners. The time had come when this country must "reach out." We wanted San Domingo; we should have had it, and would have had it ere now but for blind politicians. The time had come when the United States should say to "certain parties on the other side of the water" that if there was any land lying around loose on this side the United States was the residuary legatee of that land.

The Society, however, was not prepared to act with precipitation. A committee was appointed, not to memorialize Congress, but to report to the Society its conclusions on the subject of doing so. Rear-Admiral Meade (retired) headed the committee, and the remaining members were Thomas W. Hyde, Jacob W. Miller, U. S. Navy (retired), Lewis Nixon, and Charles H. Loring, U. S. Navy (retired).

The next day Rear Admiral Meade made a report, in which he expressed regret that he could not submit a unanimous recommendation from the committee. The majority, however, reported that it was proper and advisable for the Society to memorialize Congress on the subject; and he had prepared a form of memorial which, if there was no objection, he would proceed to read. No one protesting, the Rear-Admiral read a petition setting forth that the canal would prove an inestimable boon to humanity, but especially to these United States, and that, in the judgment of the Society, its promotion was a task Congress ought to undertake, and was accordingly petitioned to take.

Then it transpired that the minority was represented by Commodore Charles Harding Loring, formerly Chief Engineer of the Navy, a defection from his own profession and his own retirement, whence the real grief displayed by the Rear-Admiral at the lack of unanimity. Commodore Loring said his dissent was not upon the merits of the canal, but for the purpose of protecting the Society from the encroachment of extraneous objects. He feared the Society was proposing to wander off from its legitimate functions. It was established for one purpose—to promote ship-building. There was no warrant for going out of its province, as was proposed. Once done, there was no reason why the society should not be asked to take action concerning the belligerent rights of Cuba, or the annexation of Hawaii, or drawing a line on the north between the British and ourselves. There was some talk about Americanism and patriotism on the part of several who favored the report and memorial, to all of which Commissioner Loring responded from time to time that it was very beautiful, but did not answer his objection that the action proposed was outside the province of the Society. When the decisive vote was taken the report of Rear-Admiral Meade (retired), which had at first been received with apparent favor, judging from the applause, was decisively rejected by a vote of 27 to 14.

THE DOCTEUR BRICK-LINED FIRE-BOX.

FROM time to time experiments have been made upon the locomotives of European railroads with boilers in which the fire-boxes were lined with fire-brick, and the sole heating surface was that of the tubes, the water legs being dispensed with. In the tests that have been made, it almost invariably appeared that the evaporative efficiency of the boilers was fully equal to that of the standard construction, due probably to the more perfect combustion in the fire-box and the higher temperature of the gases entering the tubes with the resulting higher efficiency of the same. In our issue for September, 1893, we published a description of the Bork boiler which had a fire-box of this type, and with which an evaporative efficiency slightly in excess of that of the standard boiler was obtained. The most recent attempt in this direction has been made by M. Docteur on the Belgian State Railways, for the particulars of which we are indebted to the *Revue Industrielle*.

The Belgian State Railway has recently resumed the use of red copper tubes and coal; and tubes of this character seem to be giving satisfactory results. Also the red copper tube sheets in the smoke-boxes appear to act very well in service. But

the high price of the materials added very materially to the expense of making the boilers, the value of the worn-out plates not being a sufficient compensation for the capital invested.

It was to avoid this increase of expense that M. Docteur has endeavored to design a boiler for the least possible expense, while still preserving the red copper tube sheet in the fire-box and using the coal that the other boilers use. To do this, he has made the sides and back of the fire-box of a refractory material. It was to be feared that the design would receive a set back from the fact that it does away with almost the whole of the direct heating surface, and thus reduces the evaporating surface, which is thus confined to the crown-sheet. But experience has shown that the fears entertained as to the second point have been without any foundation whatever.

To equalize the partial suppression of the direct heating surface, the diameter of the shell of the boiler is increased, so that the number of tubes might be increased. With this provision 306 tubes are put in a boiler of this type. The excess of heating surface thus obtained permitted a number of tubes to be blocked without any injury to the regularity of the service, for the purpose of ascertaining whether or no the direct heating surface really possesses the importance that has been attributed to it. For the sake of equalizing the cutting down of the steam space due to the abandonment of the outer shell of the fire-box, M. Docteur has placed a steam-drum on top of the boiler near the front end. The volume of this drum exceeds by 25 cub. ft. the combined space in an ordinary boiler of the dome, and that above the crown-sheet in the cylindrical portion.

more influence in the production of steam than the same amount of surface in the tubes. This, at least, is what M. Docteur claims in a communication which he has made to the Association of Engineers of the Liège School, and from which the facts contained in this article are obtained.

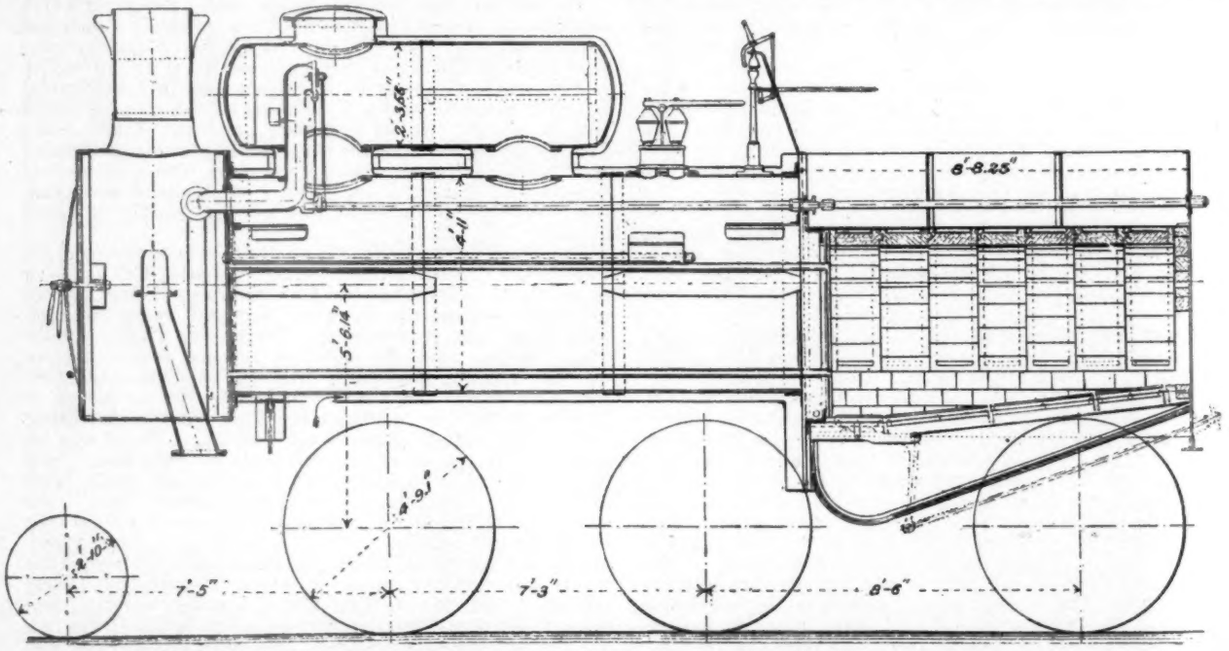
The test of the new fire-box with fire-brick walls was made on locomotive No. 512, with outside cylinders, and of which the following are the main dimensions :

Diameter of cylinders	19 1 in.
Stroke of piston	26 in.
Steam pressure	142 lbs. per sq. in.
Diameter of driving-wheels	4 ft. 11.45 in.

This locomotive has been in service since February, 1894, hauling trains of the regular weight and length. The several tests that have been made with the new boiler have given very satisfactory results from the standpoint of the evaporation of water, which has risen to as much as 8¼ to 9 lbs. of water per pound of coal burned while hauling through trains with a light load.

It was also found that the combustion of the coal in the fire-box was perfect—a result that is undoubtedly due, in the first place, to the high temperature which is maintained in the fire-box, whose walls are not continually cooled by contact with water, as is the case in the ordinary boiler ; and, secondly, to the fact that the hot air admitted above the coal burning upon the grate is sufficient to burn all of the gases that are set free by the heat of this combustion.

On being thrown into the fire-box the coal is at once raised to such a temperature that it becomes incandescent, and its



LOCOMOTIVE ON THE BELGIAN STATE RAILWAY, WITH DOCTEUR'S BRICK-LINED FIRE-BOX.

This steam drum has openings and a man-hole through which the boiler can be inspected and access be obtained to the throttle valve and dry pipe.

The accompanying illustration gives a clear idea of the assembled arrangement of a locomotive provided with this new boiler.

It was of importance to ascertain whether a fire-brick wall would stand in the fire-box of a locomotive, and learn the durability of such walls, as well as to insure the efficiency of the circulation of air between the bricks that must be maintained, not only for cooling them, but also for admitting hot air above the grates. The heating surface reduced by about 30 per cent. relatively to that of an ordinary boiler has been recognized as sufficient to demonstrate the principle ; and the steam produced has always been at least as dry as that of ordinary boilers.

The results obtained prove that it is sufficient to increase the indirect heating surface by an amount equivalent to the amount of direct heating surface suppressed, in order to obtain a production of steam at least equal to that obtained with the same total of direct and indirect surface ; in fact, by plugging tubes until the heating surface was reduced to that of the old locomotive, the operation of the engine was in no way affected. Hence 1 sq. ft. of direct heating surface has no

gases are not distilled as in other fire-boxes. The temperature of the gases upon reaching the smoke-box is never more than 720° F. at a few inches from the tube-sheet, as in the best locomotives used in freight service. The cinders deposited in the smoke-box are far less in quantity than are found in the ordinary boilers, and they are also very much smaller and cooler. The production of carbonic oxide is avoided ; the flames developed in the fire-box are clear and well defined ; the production of heat is great, yet the loss of heat due to radiation around the fire-box is slight on account of the fire-brick lining, which has a thickness of 4 in., and of the current of air passing between the bricks ; and finally the sheet-iron jacketing that is laid directly against the fire-brick has a lower temperature than that of the jacketing on an ordinary boiler.

The admission of the air which circulates between the two casings in the arch of the double wall effects a perfect smoke consumption or smoke prevention, regardless of the quality of the coal that is used ; thus, the new fire-box has been stoked with the Flénu coal for welding furnaces, with pure semi-bituminous coals, with a mixture of semi-bituminous and hard coal, and, in all of these tests, it has been impossible to detect any difference in the color of the smoke. It has been possible, furthermore, to feed the new fire-box with a mixture composed of 75 per cent. of hard coal and 25 per cent. of coking coal ;

under these conditions a very high evaporation was obtained, averaging 8 lbs. of water per pound of coal; in some cases it rose as high as 8.5 lbs. to 9 lbs. of water per pound of coal consumed; and in hauling through freight trains, where the fire-box was always at work, the evaporation was higher than 9 lbs.

While the fuel consumption of the same locomotive, with its old boiler, fired with good coal, was always more than 77 lbs. per mile, it has dropped, with this new boiler, to 54.2 lbs. on an average over a measured run of 11,625 miles.

The new fire-box has another advantage: it has been possible to reduce the draft up through the bed of coal on account of the draft of hot air which enters through the spaces left between the brick in the walls, and which enters the fire-box over the top of the coal. The consequence is that the coal is not drawn into the smoke-box, and that it is possible to use and even give the preference to light and hard coals.

Two series of tests have been made with this boiler; the first related to the consumption of fuel and water. On averaging 16 experimental runs, it was found that 7.7 lbs. of water were evaporated per pound of coal burned.

In the second series, the total work done by the locomotive was measured; the consumption of coal during the interval was taken into consideration, and finally an allowance of fuel was made to the engine for the work performed. The following are the results obtained:

Distance Run in Miles.	Virtual Units Hauled.	Consumption of Coal in Lbs.			Allowance of Fuel Made in lbs.
		Bituminous.	Hard.	Total.	
210.65	25,984	3,528	6,615	10,143	17,223
908.46	119,888	18,960	36,162	55,122	73,749
531.28	68,776	6,615	21,160	27,775	39,038
1650.39	214,648	29,103	63,937	93,040	130,010

It will be seen from these figures that the consumption of coal per mile run was about 56.38 lbs., or .43 lbs. per virtual unit hauled, which shows a saving in the total consumption of 36,970 lbs., or 33 per cent.

M. Docteur says that he is very well satisfied; and in view of the unfavorable results that were given by the same locomotive with its old boiler, he is disposed to attribute the improvement that has made itself manifest solely to the fortunate change in the boiler—that is to say, to the new type of fire-box.

Experiments were also made in order to ascertain how many square feet of indirect heating surface in the tubes would be required to replace 1 sq. ft. of direct surface in the fire-box. For this purpose, 20, 39, 51, 67, 76, and 100 tubes were successively plugged. With 20 tubes plugged, an average of four tests showed an evaporation of 8.28 lbs. per pound of coal; with 39 tubes plugged, this average was 8.2 lbs.; it dropped to 7.89 lbs. with 51 tubes plugged. Starting from this point, no further measurements of the consumption were made; but with 76 tubes plugged the boiler still furnished sufficient steam to haul the regular trains assigned to the freight locomotives on the run. This was the limit, however, for with the plugging of a greater number of tubes the steam pressure could not be maintained.

The heating surface of the boiler, before the tubes were plugged, was 15.6 sq. ft. in the fire-box and 1,707 sq. ft. in the tubes, or a total of 1,722.6 sq. ft. After 76 tubes had been plugged, the heating surface remained at 15.6 sq. ft. in the fire-box, and was reduced to 1,285.35 sq. ft. in the tubes, or a total of 1,300.95 sq. ft. These figures practically agree with the total heating surface in the locomotives of the Belgian State Railway known as type 25, which is 1,299.38 sq. ft., with 122.06 sq. ft. in the fire-box and 1,177.32 sq. ft. in the tubes.

We are, therefore, at liberty to conclude that the difference in the production of steam between the direct and indirect heating surfaces is very slight in a locomotive boiler.

Finally, tests were made in which there was no admission of air through the walls; and here it was shown that there was an immediate falling off in the production of steam, an increase in the consumption of coal, and a less perfect combustion.

The use of refractory materials for the fire-boxes of tubular boilers requires great care. It is essential that all admission of cold air should be cut off when the bricks are heated to a white heat, and that the fire should not be drawn immediately after the engine is housed, for the fire should be allowed to die out gradually upon the grate. By acting in this way the pressure can be held for several hours.

Steam has always been generated in this boiler, even from cold water, in an hour and a half at the outside, whereas it ordinarily requires at least three hours. The expansion of the shell has been very accurately measured by means of marks on the frame, and it has never exceeded .16 in. to .2 in.

These considerations have led M. Docteur to conclude that this boiler is absolutely safe; and that, furthermore, it will allow of a very important saving in the invested capital, as compared with the ordinary boiler on a freight locomotive which is of essentially the same dimensions; this saving being placed at 5,000 francs ($965).

The expense for the complete renewal of the fire-brick walls, including material and labor, will not exceed 100 francs ($19.30), and the work can be done by an ordinary mason. It should be noted that the cost of replacing a few stay-bolts of an ordinary boiler would exceed this amount. The use of this new style of boiler is expected to render it possible to effect a saving in fuel of from 10 to 12 per cent. by the admission of air above the grate.

ELECTRICAL NOTES.

The main question concerning traction systems in cities is the cost of power supply, and this is not always cheapest by the electrical plan unless the lines are so long as to render a cable system prohibitive. Another argument of growing importance is that modern requirements in large cities demand a rate of speed that the horse is not equal to.

Of all systems tried on a large scale, the cable is cheapest to run up to a certain distance. We can get more work done by hauling a load with a rope than any other way, provided only that the rope is not too long, in which case it costs too much to pull the rope alone without any car containing passengers attached to it. That is what places a limit to the economical operation of cable systems; they are cheaper for short distances, but cost more than electricity for long distances that require several cable plants.

The story of 10 years' progress in electric traction is quite as interesting as that of any single marvel the new agent has produced; and if electricity does not come out ahead in the long run, it will at least have served the purpose of driving every other system to do its best, and of driving absolute systems out of existence. A great promoter of the principle of the survival of the fittest is electricity.

There will always be unquestioned advantages in any system in which the vehicle is independent of other vehicles along the route or of a central station. This feature doubtless more than any other has been the means of drawing millions of dollars into investment in the storage battery, with no better result to-day than a system that requires about two tons of lead to haul one ton of passengers. The independent vehicle will always remain the ideal plan.

We find the distance up to which a single cable is operative is quite small when compared with that over which we can operate a trolley system from a single former station. This is one advantage of trolley systems over cable systems, and another not less important one is the fact that the overhead trolley wire and support cost very much less than the cable and its conduit per mile.

Both cable and trolley systems are open alike to the serious objection of not having an independent self-propelling vehicle. Any system free from this defect will make a strong bid for public favor, and with certainty of success if the cost is not too high. With storage systems, which alone offer this advantage, the cost is too high, and in the present state of the art this unfortunate defect seems to be without remedy. As for the horse, he costs just about as much as the storage battery to run, and is just about as dirty and troublesome.

In respect to its traction systems, New York is singularly behind other large cities in adopting the latest improvements; but this seems to be the result of conditions that strangely justify her course. Thus, the elevated system of New York City was brought to completion long before the perfection of the electric car motor. When the electric car first came on the scene, the elevated in New York had been long completed on all the avenues on which it now runs, and steam became the motive power by mere accident of time.

One new departure from cable practice has been made by the Metropolitan Traction Company, of New York. Within the current year they have ventured the trial of an under-

ground trolley line for a few miles on Lenox Avenue, and it has given satisfactory results thus far; the severity of winter is, however, the crucial test that will determine its staying powers.

Out of the many good systems offered this company, the one laid down was selected, it seems, for the reason that if it failed to work satisfactorily—and it probably will in time—it can be taken up without great loss and a cable laid in its place, the conduit being equally well adapted to both systems—in fact, the system seems to have been put down with failure in anticipation. The same system was a failure in Chicago; it was tried in Washington, and failed there. Let us hope for a surprise in New York. It is almost identical in principle and construction with the Buda-Pesth system, so long in use there under much better conditions of climate. It has not yet shown itself equal to the rigors of a Northern winter in the States. There are numerous underground trolley systems that surpass it in reliability and certainty of action, and numerous systems that require no slot are far superior to it. In the Lenox Avenue system the voltage used is only 300, and the current is taken from two bare copper wires that extend from end to end of the conduit, less than a foot apart. If anything bridges these wires that will conduct the current at the voltage used, then serious trouble will follow. Normally the current goes from one lead to the other only through the motor on the car, and it will go that way and do its work propelling the car as long as there is no easier path for it; but a most persistent feature of electricity is that it seems to be always looking for some other path than the one intended; give it half a chance, and it finds the other way to a moral certainty. Some day the conduit will fill with water or slush, which will bridge the two wires, and the electric current won't wait another instant. Strange to say, among the comparatively few electric roads in Europe, 50 per cent. or more of them are underground trolley systems.

Electric Locomotives.—It is announced that the Baldwin Locomotive Works have received orders for a number of electric locomotives for passenger train service, and are at present building two freight locomotives designed to haul trains of 800 tons. Two of the freight locomotives, it is reported, are for the Westinghouse Company, to be used for switching purposes in their yard at Pittsburgh.

Stationary Electric Motors.—From statistics of the United States Electric Census of 1890, which has but recently appeared, it seems that in that year there were 2,363 stationary electric motors in use in the State of New York. These machines, all supplied from central stations, aggregate about 3,000 H.P. Of the entire number, 668 were run on a metre service, and yielded a return of $67,550, while 1,695 were supplied with current by contract, yielding $117,655.

Elevated Electric Railroad.—A company has applied to the New York Railroad Commissioners for permission to construct an elevated electric railroad through Long Island. The bicycle road recently in operation at Bellport, L. I., is to be practically the model of the proposed road. The rate of speed on the road is to be from 50 to 65 miles an hour. In answer to a question by Mr. Kelly, Mr. Denton, the president of the petitioning company, said that some time the company expected to run its cars at a speed of 100 miles an hour!

St. Louis likely to Have an Electric Conduit Railway System.—Wherein lies the good judgment or discretion of putting down an electric conduit railway system of questionable merit, and certainly not the best, simply because it offers peculiar facilities for changing over to the cable in case of failure? When will this anticipation and expectation of failure end? With the many good systems available, this practice should be at an end now, but it is not. On the new Third Avenue Line the old "Love system"—not unlike that on Lenox Avenue—is going down, and now comes news from St. Louis that a similar system is likely to be selected for a new line in that city; this, however, we are given to understand, is contingent upon the Washington system standing the test of the present winter successfully.

Incandescent Light Patent.—It was announced in the daily papers that on November 11 the Supreme Court of the United States, in an opinion read by Justice Brown, in Washington, sustained the Edison incandescent light patent against the claim of the Consolidated Electric Light Company, using the Sawyer-Mann system, of which it was claimed that the Edison system was an infringement. The case came from the United States Court for the Western District of Pennsylvania, which gave judgment in favor of the Edison company.

The court below decided, first, that the Sawyer Mann patent was invalid because of amendments to the application, which made it in effect a new application; and, second, that the priority of invention was with Edison, the experiments of Sawyer and Mann never having resulted in a successful system of lighting.

The second point, Justice Brown said, had not been considered by the court, because the conclusion on the first disposed of the case. It was their opinion that the claim of a conductor composed of carbonized fibrous and textile material is too broad to sustain the patent, and it must therefore be declared invalid. They could not by such a claim shut out all other investigators into the field of vegetable fibre. As a matter of fact, the justice said, Sawyer and Mann had confined their experiments to carbonized fibre and charcoal. Edison and his assistants had examined 6,000 articles in their search, and finally fixed upon the cuticle of a species of bamboo as the best thing for the conductor. Sawyer and Mann abandoned the materials they had used in their early experiments, and had adopted the material used by Edison. Yet they claimed that their patent was broad enough to exclude Edison's material and make his use of it an infringement. This could not be sustained, said Justice Brown: the claim was entirely too broad. The Sawyer and Mann patent was, therefore, invalid, and the judgment of the court below to that effect was affirmed.

The result of this decision, it is said, is to throw open both systems to the public. The Sawyer-Mann patent is invalid, and the Edison patent expired, by a coincidence, just a year ago to-day, under the operation of the decision in the Bate refrigerating patent case.

Underground Trolley Roads.—The coming year bids fair to bring considerable development of underground systems. Just as we go to press information is received of the decision of the Metropolitan Traction Company, of New York City, to lay a trial piece of track equipped with the Johnson-Lundell sectional midrail system, the successful working of which will undoubtedly insure the adoption of this system for other new lines, as well as those where a change is deemed advisable. As this system unquestionably has the endorsement of John D. Crimmins, there is every certainty that it will be a winner.

Aside from this fact, however, the system is one of the best ever tried; it has few equals if any superior, and might well have been installed on Lenox Avenue, where the Buda-Pesth system is now undergoing test. A description of the Johnson-Lundell system will be given in due time. In general terms, it is one in which the car gets its current from mains buried in a closed conduit through a trolley wheel that runs along a middle rail in the centre line of the track. This middle or current-supplying rail is broken into insulated sections less than the length of a car, and these sections are successively cut into circuit with the mains below as the car approaches them, and cut out of circuit again as the car leaves them in such a way that there is no live rail in the middle of the track except that section immediately beneath the car. The Johnson-Lundell system is not unique in this respect, as there are quite a number of systems that are operated upon this same general plan. It is, however, unique and fairly apart from systems of this sort in the respect that gives it one advantage over others for city work. It is what might be described as a composite system, inasmuch as the car carries a storage battery of sufficient capacity to operate the car for a short distance independently of any connection with the main current underground. This means that the car can go a considerable distance independent of the central station supply. The advantage thus given for making complex street crossings where for a distance the underground supply can be discarded is not inconsiderable. There are means, of course, provided for resupplying the exhausted battery after such a run by connecting it to the power circuit, and thus put the battery in shape for the next independent trip.

Since our last issue, the Madison Avenue Line, in this city, has been equipped with a trial storage battery car provided with the chloride accumulators of the Philadelphia Storage Battery Company. The first trip was made at night more than a week ago, and the morning papers all had the customary associated press report to the effect that the trial was a complete success in every respect, the car starting off with the expected speed and with as much power as if it were drawn by a locomotive. The car took the sharp curves without slackening speed, while the lights in the car were of unusual brilliancy.

Germany is always surprising us with some novelty in electric application. We now have an electric suspension railroad between Leipsic and Halle. The system is credited to Eugene Langen, of Cologne, and the novelty is described in the meagre reports at hand as the suspension of the cars from an overhead trolley rail (wire). There is nothing new about this, however, as it is one of the oldest plans of electric locomotion devised, and was of British origin. Its serious application to

cross-country railroading, however, is novel and rather surprising. The line from Leipsic to Halle is 22 miles long and the distance is covered in 35 minutes, with the promise that it will be reduced to 20 minutes, or at a rate of considerably more than a mile a minute. The report goes on to state that the line is attracting the close attention of the Berlin authorities, with a view to its adoption for an intramural line for that city.

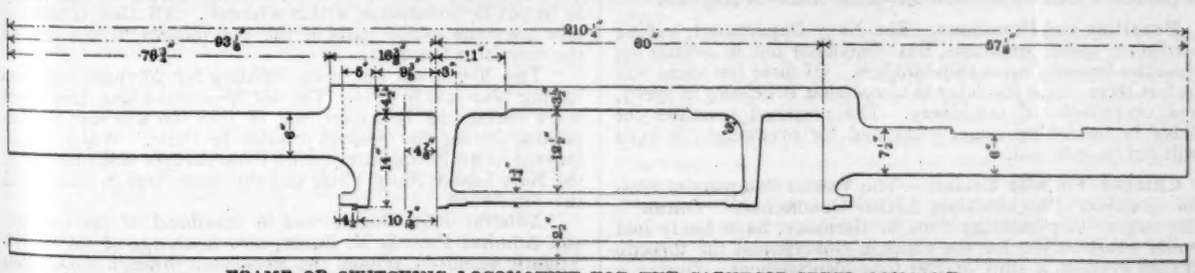
SWITCHING LOCOMOTIVE FOR THE CARNEGIE STEEL COMPANY.

SWITCHING service is undoubtedly the most severe service that the ordinary locomotive is called upon to endure, and in this, as in everything else, there are degrees of severity; but of all the work that a locomotive may be called upon to perform, that of a steel works is perhaps as hard as any. The locomotive is usually slammed about as though it were made of imperishable and unbreakable materials, and the only way in which a satisfactory service can be obtained is to make all of the parts so strong that they simply cannot be broken. The locomotive of which we give illustrations is one that has recently been completed for the Carnegie Steel Works, Limited, by H. K. Porter & Co., of Pittsburgh. The engraving, reproducing the photograph, does not give an adequate idea of the weight and strength of the details of the engine. The following are a few of the principal dimensions:

Gauge of road	30 in.
Weight of locomotive in working order	41,000 lbs.
Total wheel base	5 ft. 6 in.
Diameter of cylinders	12 in.
Stroke of piston	16 in.
Diameter of drivers	33 in.
Maximum working pressure	140 lbs.
Water capacity of tank	750 galls.
Kind of fuel used	Bituminous coal.
Total length of engine over bumper beams	19 ft. 2 in.
Height top of rail to top of stack	9 ft. 4 in.
" " " " " centre of boiler	4 ft. 9⅛ in.

When we take these figures and compare them with those given on the detail drawing of the frame, it will be seen that the latter is remarkably heavy. In fact, the forward end is almost if not quite as heavy as the corresponding portion on many standard-gauge locomotives with 16-in. or 17-in. × 24 in. cylinders. The front buffer casting, which is not clearly shown on the engraving, is of steel, and weighs 750 lbs.—an excessive weight, to be sure, but one that was found to be necessary in order to withstand the hard usage to which the locomotive is subjected without breaking. The sides of the engine are well protected by aprons, so as to prevent the dust and ashes that fill the air about the works from settling on the working portions of the machinery. This type of engine presents no novel features in its outward appearance, and its peculiarities lie entirely in the great weight and strength of its parts, which is evidenced from the fact that on a gauge of only 30 in. it weighs more than 2,000 lbs. to the running foot of length.

SWITCHING LOCOMOTIVE BUILT FOR THE CARNEGIE STEEL COMPANY BY H. K. PORTER & CO., OF PITTSBURGH, PA.



FRAME OF SWITCHING LOCOMOTIVE FOR THE CARNEGIE STEEL COMPANY.

NOTES AND NEWS.

Plenty of Lumber Still Left.—It is said that Canada has a forest in the Hudson Bay and Labrador region 1,000 by 1,700 miles in extent; another great forest stretches from Washington State to Alaska. The Amazon basin comprises, perhaps, 2,100 by 1,300 miles of forest. Central Africa has a forest region of 3,000 miles from north to south of an unknown width. Again, the "Taigas" and "Urmans," or vast pine, larch, and cedar forests of Siberia, are 3,000 miles from east to west, and 1,090 miles from north to south. The natives call them "places where the mind is lost."

Life-Saving Service.—In his annual report the General Superintendent of the Life-Saving Service gives the following remarkable data:

"At the close of the last fiscal year the establishment embraced 251 stations, 184 being on the Atlantic, 53 on the lakes, 13 on the Pacific, and one at the Falls of the Ohio, Louisville, Ky. The number of disasters to documented vessels within

the field of the operations of the service during the year was 483. There were on board these vessels 5,402 persons, of whom 5,382 were saved and 20 lost. The estimated value of the vessels involved was $8,001,275, and that of their cargoes $2,645,960, making a total value of property imperilled $10,647,235. Of this amount, $9,145,085 was saved and $1,502,150 lost. The number of vessels totally lost was 73. In addition, there were 192 casualties to small craft, such as small yachts, sailboats, rowboats, etc., on board of which there were 421 persons, 415 of whom were saved and 6 lost. There were 110 other persons rescued who had fallen from wharves, piers, etc., the most of whom would have perished without the aid of the life-saving crews. The crews also rendered assistance of minor importance to 181 other vessels in distress, besides warning from danger by the signals of the patrolmen 249 vessels. The number of lives and amount of property saved through these warnings is, of course, not known."

The Superintendent pays a high tribute to the heroism of the men in the service, and says that no life was lost through the lack of prompt and faithful effort.

Navigating the Air with Kites.—Lieutenant B. Baden-Powell described a means he suggested for navigating the air by means of kites. He pointed out that as greater height above the surface of the earth is reached, the wind nearly always increases in force. At 1,000 yds. it often blows at three times the velocity that it does near the surface. He proposes to take advantage of this difference by sending one kite to the upper atmosphere, and keeping another nearer the ground. The two kites would be connected by a long line, and the weight to be carried would be attached to the line at a point nearer to the lower kite than to the higher. The lower kite would thus supply a retarding medium to the upper, so that the effect would be the same in principle, though not in degree, as if the upper kite were held to the earth by a string, and the lower kite were towed through the air by a boy running with the string in his hand. By the forces thus brought to bear both kites would be kept flying, although not held to the earth by a string in the usual way, and it is thought that possibly they might be navigated in directions other than that in which the wind might be blowing. It will be seen that the author depends on the difference in velocity of currents of air at two heights; and were this difference to fail, or to become insufficient, the experimenter would come to the ground. This might prove awkward unless a clear field were provided for the descent. The suggestion, however, is ingenious, and no doubt many persons interested in the problem of aerial navigation would be pleased to see the author put his theories to the test of practice.—*Nature.*

MARINE NOTES.

Triple Propellers.—Germany is going to try the triple propeller system on several of her new war ships. The only triple-screw steamer she now has is the *Kaiserin Augusta.*

Penalties and Premiums.—The Navy Department, having abolished speed premiums, has concluded not to overdo the penalties imposed upon ship-builders. Of these last there will be but three, those for delay in completion, deficiency in speed, and overweight of machinery. The proposed penalties for delay in furnishing armor plans and for overweight in hulls will not be enforced.

Chinese Torpedo Cruiser.—The Vulcan Company of Stettin (Stettiner Maschinenbau Actien Gesellschaft "Vulcan"), the largest ship-building firm in Germany, have lately had under construction for the Chinese Government the torpedo cruiser *Feiying*, a ship of 850 tons displacement. During a full-speed trial of four hours duration, which has just taken place, this vessel attained a speed of 22 knots, with engines (made by her builders) developing 4,500 I.H P., steam for which was obtained from eight Yarrow water-tube boilers having straight tubes, under an air pressure in the stokeholds of only ¾ in. of water.

Report of Chief Constructor Hichborn of the U. S. Navy.—In his annual report the Chief Constructor says that modern steel ships, with their extreme subdivision and elaborate systems of ventilation, drainage, and mechanical auxiliaries of all kinds, require much greater care, both when in commission and in ordinary, than was formerly the case with the old wooden ships; neglect is followed by much more serious and far-reaching deterioration, and it is absolutely essential that the most careful supervision should be exercised at all times and remedies promptly applied in order that the efficiency of the vessels as men-of-war may be properly maintained, and insists that a much larger appropriation is needed this year than last to maintain our ships in a proper state of efficiency. He recommends the construction of only two new vessels to be authorized by the next Congress instead of the great increase to our force of heavy battleships which was unofficially suggested by his paper read before the Naval Architects in New York as being promptly needed by the Navy. The vessels he recommends are two small composite sailing vessels of 1,100 tons displacement, to cost only $250,000 each These, if authorized by Congress, will be the first two vessels without steam power that have been placed in the naval service for many years.

He recommends new docks at Portsmouth, N. H; Boston; Mare Island, Cal., and Norfolk, Va. Until the indefinite time in the future, when the big docks at New York, Puget Sound, and Port Royal are available for deep-draft vessels, the battleships must remain undocked.

Bids for Battleships and Armor.—According to the New York *Sun*, the bids for the new battleships will be opened on the last day of this month, and sharp competition is expected. The armor proposals will also soon be opened. It is observed that the words "Harvey process" are not used in the specifications, but the 7,000 tons of armor called for are to be "in whole or in part, at the discretion of the department, face hardened." It is further said that the hardened plates are to be super-carbonized before forging, and then reduced to the required thickness by forging or rolling at as low a heat as practicable, thus utilizing the results of recent experiments. When finally machined and shaped it will be hardened. The 15 in. side armor will be fired at with a 12-in. gun, and the 17-in. turret plates with a 13-in., which last has never been used in the contract tests even of 18 in. plates. But the increased severity of the tests is warranted by the growing excellence of the plates.

From the same source the following items are quoted:

"Bilge keels, it is said, were omitted from the *Indiana* and other vessels in order to get them into the docks, but the decrease of stability thereby occasioned will probably cause them to be restored.

"An interesting trial, which may soon be expected at Indian Head, is that of the experimental turret representing a similar structure on the battleship *Massachusetts.* It has a double purpose, the primary one being to determine the acceptance or rejection of a group of armor which the plate fired at represents, and secondly the effect of the impact upon the frame. Finally, if the plate is left in condition to be fired at after the contract shots with the 12-in. gun, it will receive a round from the 13 in.

"The report on the test of the Browning automatic gun shows that it gave good results."

Monitor "Monadnock."—An Associated Press report, dated San Francisco, says of this vessel: "Steam was raised in the *Monadnock* on Thursday, October 24, when the vessel was given a dock trial at Mare Island, Cal., to test her machinery. The warship will be entirely completed and ready to be put in commission within a month. All that is lacking now are some minor parts of the gun-mounts, which are on the way from the East.

"The *Monadnock* has been building for 20 years, her keel having been laid in 1874. The old *Monadnock* had done good work during the Rebellion, and in 1866 she was sent to Valparaiso during the Spanish trouble in Chile. When things quieted down in the latter country the monitor was ordered to the Mare Island Navy Yard, and she came here in convoy of the *Vanderbilt.*

"Admiral John Rogers was in command of the convoy, and Admiral Francis M. Bunce, now in charge of the North Atlantic squadron, piloted the *Monadnock* through the Golden Gate. It was in Secretary Robeson's time that Congress began measures looking to the rehabilitation of the Navy. Finding that it was impossible to get appropriations for new ships, Robeson conceived the idea of having the old vessels rebuilt. The expense attached to this came out of the fund for repairs An order was made to rebuild the *Miantonomah, Amphytrite, Terror, Puritan* and *Monadnock.*

"The contract to rebuild the *Monadnock* was let to Secord & Vanderbilt, but the frame-work was done by a firm in Williamsburg. The monitor was put up in frame entirely and then taken apart and the plates shipped to Mare Island in a sailing vessel around the Horn. For years the plates lay exposed to the weather at the foot of Pennsylvania Street, in Vallejo, Cal., where the keel was laid. The ways are still there, and are known as Monadnock Wharf. The appropriations for the "repairs" were very small, and the work was delayed. Several times the plans had to be altered to conform

with the modern requirements, and now it is declared that the *Monadnock* is one of the finest and most efficient warships afloat.

"The *Monadnock* is a double-turreted monitor, and will carry two 4-in. guns in each turret. Her secondary battery will consist of Hotchkiss and Gatling guns. She will carry from 180 to 200 men. The big rifles have been at Mare Island for some months, and are housed over with canvas. The trial trip of the monitor will not be made until the vessel has been ordered into commission. When she goes to sea she will have on board all her men and stores. No officer has as yet been assigned to the command of the *Monadnock*.

"The old *Monadnock* was dismantled at Monadnock ways. Her turrets were removed, and her timbers have been cut up into relics of former glory."

Report of Engineer-in-Chief Melville to the Secretary of the Navy.—In his annual report to the Secretary of the Navy, Commodore George W. Melville points out the necessity for establishing repair stations for war vessels at several of our navy yards, including the Boston yard. He endorses the recommendations of a board for making the League Island yard, near Philadelphia, a naval station second to none in the world. The advantages and surroundings, says the Chief, are too well known to need repetition, and there is every reason why this should be the principal naval station for building, repairing, and laying up modern ships. The Norfolk Yard is well adapted for a building and repair station, and an engine construction plant should be erected in conjunction with the new naval dry dock at Port Royal, S. C. The machine shop at the Newport naval station is too small, and should be augmented. A number of shops to repair machinery and boilers should be erected at once at the Sidney, Wash., naval station. On account of the strategic position of the Key West naval station, Commodore Melville hopes for the establishment there of a suitable engineering plant, which could be used by the commercial marine in an emergency.

In making recommendations as to the use of water-tube boilers, Chief Melville says he appreciates the necessity of proceeding with caution and yet keeping abreast of progressive builders. No single type of water-tube boiler has yet made its appearance which can be regarded as an altogether satisfactory substitute for the Scotch or cylindrical fire-tube pattern, and for this reason the Chief has not recommended their use in the larger and more important vessels, believing it better, for the present at least, to confine them to torpedo-boats, gunboats and the smaller cruisers.

"Conservative as this bureau may be regarded upon this subject," says Commodore Melville, "it has been in advance of every marine engineering establishment in America, for while private firms refused to guarantee a water-tube boiler for naval purposes, the bureau insisted upon their installation as a part of the power in the coast-defence monitor *Monterey*."

It is said by the New York *Sun* that "as a result of the examination by Chief Engineer Perry and Passed Assistant Engineer Bryant of the lake steamer *Zenith City*, a freight boat, water-tube boilers of a pattern similar to hers are likely to be put on the new composite gunboat to be built at Elizabethport, on one of those awarded to the Union Iron Works at San Francisco, and on one of those secured by the Bath Iron Works."

The Chief suggests that one of the gunboats now building at Newport News would be an admirable vessel for testing the merits of liquid fuel. The attention of the department is called to the fact that the number of naval cadets in the engineer division now being graduated at the Naval Academy is not sufficient to supply the vacancies in the Engineer Corps, and he says that if some means for increasing the division can not be found, recourse must be had to the technical schools and colleges.

The Ram "Katahdin."—The Ammen ram *Katahdin*, which was so long in constructing, has recently had her trial. In the contract under which she was built it was provided that unless she would make a speed of not less than 17 knots per hour, maintained successfully for two consecutive hours, during which period the air pressure in the fire-room shall not exceed 2½ in. of water, the vessel to be weighted to a mean draft of 15 ft., she shall be rejected. During the trial she made only 16.13 knots.

Secretary Herbert said that he was powerless to waive the specifications of the contract, which stipulated that unless the ram developed 17 knots or over, the vessel should be rejected. After a long conference with General Hyde, the builder, the Secretary, however, consented to take care of the vessel at the New York Navy Yard pending a further consideration of the matter by President Cleveland.

The keel of the vessel was laid in 1891, and ever since that time frequent modifications have had to be made in the plans because of the discovery of defects. She was delayed two years by the failure of the armor contractors to fill their contract, and in the past year four different sets of propellers have had to be tried on the vessel.

It is claimed by the contractors that, as the model for the hull of the vessel was furnished by the Navy Department, they should not in justice be held responsible for her failure to make the required speed.

The New York *Sun*, from which the above items are taken, says:

"The *Katahdin* has been a long time getting into service. The act authorizing her became a law March 2, 1889, but although the designs of Rear Admiral Ammen were adopted, it was a long time before the plans were in readiness. When the bids were opened on December 20, 1890, it turned out that there was but one proposal for her, at $930,000, made by the Bath Iron Works, and to it the contract was awarded on January 28 following. After the contract was made, changes were suggested and agreed to, which increased the length of the vessel 8 ft., thus giving greater berthing capacity for the crew and space for coal storage; and it was also decided to admit a battery of four 6 pdr. rapid-fire guns, to afford protection against the attack of torpedo boats. Another change was the substitution of a solid steel casting for the stem in place of the ram with removable head originally designed, while the alteration in the shape of the stem secured better manœuvring qualities and greater strength. The height of the conning tower was also increased.

"Much confidence is expressed that the *Katahdin* will be a valuable ship. Her speed trial on Thursday showed her capabilities for her work. She is strongly constructed, and has 72 water-tight compartments between the inner and outer skin. The maximum of her armor is only 6 in., with the exception of the conning tower, which is 18 in., but the curve of her deck aids her defensive strength. Her normal coal supply is 175 tons, and her full bunker capacity about 193, which is ample, as her mission is that of harbor defence."

A New Hydraulic Propelled Steam Lifeboat.—Messrs. Thornycroft & Co., of Chiswick, England, have recently completed a hydraulic propelled lifeboat for the National Lifeboat Institution of Holland, the hull of which was designed by Mr. G. L. Watson, the naval architect of the institution. The *Times* gives the following description of this boat:

"The dimensions of the new vessel, which is built entirely of steel, are: Lengths, over all, 55 ft.; on the water-line, 53 ft.; breadths, moulded, 13 ft. 6 in.; over sponsons, 15 ft.; and extreme, 16 ft., the moulded depth being 5 ft. 6 in. She has an extreme water draft when fully loaded of 3 ft. 3 in.; the load consisting of crew, four tons of coal, mast and sails, some 30 or more passengers, and her tanks full of fresh water, which, with the propelling machinery and boiler, give her a displacement of about 30 tons. The hull of the boat is divided into 18 water-tight compartments, two of which are occupied by the engines and boiler and two forming the coal bunkers, each being capable of being freed of water—the smaller by means of a portable deck pump and the larger by the main engines.

"The propelling machinery consists of a compound surface condensing engine, driving direct a nearly horizontal centrifugal pump, the impeller of which (30 in. in diameter) delivers the water with which the pump is fed, by a scoop-shaped inlet amidships, through four nozzles or outlets in the sides of the boat, two for motion ahead—one on either side—being placed below the water aft, and those for motion astern, close under the sponsons above water, forward. The engine has no reversing gear, but is always running one way, the direction of the boat ahead or astern being controlled by valves in the discharge pipes from the centrifugal pump. These controlling valves can be worked either from the engine-room or by the coxswain at the steering wheel, and by moving one valve only the boat may be made to turn round on her centre, and may consequently be steered independently of the rudder. The boiler for supplying the engines with steam is one of Mr. Thornycroft's patent water-tube type, and is capable of supplying ample steam at a pressure of 145 lbs. per square inch to enable the engines to develop about 250 I.H.P.

"The lifeboat is steered by an ordinary deep rudder, which is moved by simple worm gearing and fitted with an arrangement for tricing it up in shoal water, without interfering with steering operations. For working the anchor and warping purposes a steam capstan, driven by an independent engine, is fitted at the after end of the engine-room, a reel of 100 fathoms of flexible steel wire rope being fixed in the cockpit or well of the boat. To assist the propelling power and the steadying of the boat it is fitted with a mast hinged in a tabernacle forward, and when not in use is lowered and stowed along the covering

of the machinery. When in use it carries a lug sail and stay-sail.

"She has been christened the *President Van Heel*. During her trial trips she made a speed of 9.294 knots. After the speed trials the lifeboat was tested in turning evolutions with and without the use of the rudder, and it was especially remarked how easily she was put about or her head put in her desired direction quite independently of that directing instrument. The boat is not only capable of propelling herself, but can at the same time take out with her two or three ordinary lifeboats to the scene of a wreck, her towing power being remarkable, an experiment to test this having been made, when it was found that she had a dead pull—measured by the dynamometer—of 22 cwt., sufficient to enable her to take in tow out of danger a vessel averaging from 200 to 250 tons burden.'

The "Magnificent."—The *Magnificent* is a first-class barbette battleship, which has recently been completed for the British Navy, and has recently had her speed trials, the particulars of which are taken from the London *Times:*

"The *Magnificent* is 390 ft. between perpendiculars, has a beam of 75 ft., and her mean drafts at the time of the trials were 24 ft. 11½ in. for the natural and 24 ft. 8½ in. for the induced draft. Her fully loaded displacement is about 14,900 tons. She was laid down on December 18, 1893, and floated out of the dock she was built in on December 19, 1894, so that within 20½ months she has been built, engined, and so far completed as to have undergone her steam trials, a rate of construction unprecedented in the annals of our royal dockyards and private engineering establishments.

"The propelling machinery of the *Magnificent* is designed to develop 10,000 I.H.P. under natural draft and 12,000 I.H.P. under forced draft. It consists of two complete sets of triple-expansion engines in separate engine-rooms, each having three inverted cylinders of 40 in., 59 in. and 88 in. diameter respectively, with a piston stroke of 51 in. Each set of engines drives a four-bladed gun-metal screw propeller 17 ft. in diameter and 19 ft. 9 in. pitch., the crank and propeller shafts being of forged steel. Steam is supplied to the engines by eight single-ended boilers of the ordinary cylindrical marine type, with four furnaces in each, and are made for a working pressure of 155 lbs. per square inch. They are designed to supply sufficient steam for the engines to develop 10,000 I.H.P. under natural draft and 12,000 I.H.P. with induced draft. The ship has coal bunker capacity provided for 1,850 tons, equal to a coal endurance for 28 days at a 10 knot speed, the coal carried at her load draft being about 900 tons.

"The higher efficiency of her boilers is attained by fitting large air suction fans in their uptakes, which are run at a speed that will cause a less pressure in them than with mere natural draft; and thus to suck or draw, by difference of pressure, the ordinary air of the stokeholds through the fuel in the furnaces instead of forcing through what is practically compressed air, as when the closed stokehold system is adopted. To create this induced draft the *Magnificent's* boilers are fitted with eight air fans, each 8 ft. 6 in. in diameter, driven by independent engines, which can be worked together or separately, as may be required, provision being made for returning to natural draft at any moment.

"The temperature of the stokeholds during the induced draft trials was never high. This was due to the fact that they are always open to the external air, while in the case of forced draft they are shut off entirely from it. An important point in the application of induced draft to boilers is the keeping of the temperature of fan chambers and casings as low as possible. This is provided for by the application of asbestos linings and ample air passages around them."

Under natural draft and a pressure in the boilers of 150.5 lbs. per square inch the engines developed 10,301 total I.H.P., and the speed of the ship was 16.5 knots per hour; under induced draft the engines, with 154 lbs. pressure, developed 12,157 H.P., and the speed was 17.6 knots. The *Times* says, further:

"As opinions are divided as to the advantages of induced over forced draft applied to marine boilers, the trials of the *Magnificent* have been looked forward to with special interest. They are so far conclusive as to prove that an increased pressure of steam may be more quickly raised and maintained. There is also a decided gain so far as the health, comfort, and safety of all who are engaged in the boiler stokeholds are concerned."

The Battleship "Texas" Injured in Docking.—The daily papers have recently contained long and somewhat sensational accounts of injury to the *Texas* when she was placed in the dry dock in Brooklyn in the early part of November.

The *Texas* was authorized by Congress in August, 1886, to be built from designs which were furnished by William John or Johns, of the Barrow Ship-Building Works, in England, who designed the *City of Rome*, etc. His plans, it is said by a writer in a New York paper, although endorsed by Commodore F. E. Chadwick and Lieutenant B. H. Buckingham, naval attaches of the United States Legation at London and Paris respectively, were soon afterward utterly discredited by another English expert—Mr. Bryce-Douglas—who had succeeded Mr. Johns in the Barrow Company. This expert, who was paid an additional $7,500 for engine designs for the *Texas*, informed Secretary Whitney that under the Johns plans the *Texas* would not be able to carry the weights and required displacements, and advised an addition of 10 ft. to her hull, giving 370 more tons of displacement, or a total of 6,670.

Secretary Whitney favored proceeding on the old plans, and Chief Naval Constructor Wilson declared that such a course would prove disastrous. Whitney had his way, and was supported by Assistant Naval Constructor Bolles.

The Secretary of the Navy was very much criticised at the time for going to England for plans of a ship.

She was built by the Government at the Norfolk Navy Yard, and was launched in June, 1892.

The displacement of the battleship is 6,300 tons; length, 290 ft.; beam, 64 ft.; draft, 22½ ft. She is protected along each side by a nickel steel belt 116 ft. long and 12 in. thick. Her battery consists of two 12-in. guns, six 6-in. guns, four 6-pdrs., four 3-pdrs., and six torpedo-tubes. Her cost was about $3,000,000. A writer in the *Sun* says: "There has been much criticism, too, on the construction of the vessel. In the opinion of many she is structurally weak."

Among the other developments during construction which increased the impression that her hull was not strong, was the accident to her boilers when they were first filled, the weight of the water breaking the saddles which supported the boilers. A bed plate of her auxiliary engines broke during the dock trial at Norfolk, the accident being caused, it was asserted, by the excessive flexibility of the hull.

The *Texas*, when completed, turned out to be the only vessel of the new navy that had not exceeded her designed draft. This, it is contended by naval officers, is due to the fact that much of her iron work was intentionally made lighter in weight as well as in strength, the sacrifice having been made in order that she might float higher, and in order to secure her completion, as far as possible, within the price fixed by Congress.

An official investigation and report of her injuries has been made by Naval Constructor Bowles, who reports that the ship was carefully docked and every usual precaution observed. "The bending of the brackets and floor plates," he says, "was due to the bending up of the ends of the cab blocks. The structural strength of the ship was not affected."

As the *Columbia* was also injured in docking recently, we have reprinted elsewhere for the benefit of our naval brethren some suggestions communicated by a correspondent of an English paper describing what he says is a safe system of preparing for and docking men-of-war. The editor of the paper says:

"It is a matter of common knowledge among those in charge of graving docks, that a war vessel, on account of its heavy weight, requires much more careful management and much more support than an empty merchant vessel. In view of this fact, the following communication from a correspondent who has had considerable experience in such work may be of interest:

THE DOCKING OF WARSHIPS.

"'Having noticed in the Liverpool *Journal of Commerce* of August 15, 1895, that the United States cruiser *Columbia*, while being docked at Southampton, received slight and local straining forward through supposed insufficient support and wrong placing of shores, it may be of interest to your readers to receive a good and safe system of preparing for and docking men-of-war.

"'Previous to the vessel being docked, and before the water is let in, the surface of the docking blocks should be examined and tested to have the same declivity as the vessel's water-line in reference to the keel-line.

"'This is easily performed by having a declivity batten about 20 ft. long, with its upper edge horizontal, while its lower ditto rests on the surface of the blocks, testing it along the whole range of the blocks. The key blocks are generally of iron, and those in contact with it iron cased, when if the remaining blocks are of wood it will be necessary to lash them to eyebolts in the bottom of the dock to prevent their being misplaced by the inrush of and buoyancy of the water.

"'The position intended for the bow and stern of the vessel are marked on the upper side of the dock; distance lines are

prepared, marked by knots at equal distances on each side of the centre weight. These are tested for accuracy, to prevent the unequal stretching of the cord. If possible the shores are prepared by fixing temporary sections at intervals on the corresponding parts of the blocks—say four or six sections, one being at amidships—and the length taken.

"'The shores should be fitted as near as possible square to the curvature of the ship at the parts selected, and, if possible, in a line with the several decks, bulkheads, and at the junction of intercostal and transverse framing.

"'Their number should be increased in the region of extra weight, such as turrets, barbettes, machinery, and the overhanging extremities—*i.e.*, stem and stern should receive extra attention.

"'The heads of the shores should be pointed above a level to avoid the strain on them having a tendency to prevent the vessel from lifting after the water is admitted for undocking purposes.

"'The vessel having been brought to the dock entrance with the bows facing up the dock, bow ropes are passed along the dock sides round steam capstans, and by this means she is hauled into dock; at the same time, if there should be any set of the tide outside the dock, the stern is kept in its proper position by steam tugs. She is thus brought to her allotted position over the blocks, when the gates are replaced and the water pumped out. She is next tried to be over the centre line of the blocks by means of the distance lines at the bow and stern, and all list prevented by proper disposition of weights on board, and checked by a plumb line down the hatchways; also by outwinding a vertical batten placed at the head of the dock—in the line with centre of blocks—with similar uprights on board or by the line of the masts. When she has settled on the blocks the breast shores are set taut; then the other tiers of shores in succession, simultaneously on both sides of the ship. By this means each part of the vessel is properly supported, and the blocks bear their due proportion of the weight.

"'Often in position of great local weight, the double bottom space is shored, and diagonal shores fitted to the decks to prevent any possible deflection at these parts.

"'The great principles in docking men-of-war are:

"'1. To have the blocks fitted to the same declivity as the draft of the ship, so that her keel may touch along its whole length simultaneously.

"'2. To keep the ship on the true centre line of the blocks, and avoid all appearance of list.

"'3. To concentrate the shores in the positions of greatest weight, and at the place of greatest strength—*i.e.*, line of decks at side, bulkheads, and at the intersection of longitudinals, with transverse framing. If this is carefully attended to, no possible straining or deflection would ensue.

"'THOMAS H. SCURLOCK,
"'*First Medallist Naval Architecture.*'"

SHOP NOTES.

NEW YORK, SUSQUEHANNA & WESTERN RAILROAD, NORTH PATERSON SHOPS.

MR. ENNIS is much pleased with his new Rogers 19-in. × 24-in. mogul freight engines. They have 54-in. wheels on a rigid base of 14 ft. 6 in., and 22 ft. 3 in. total. Weight on drivers, 110,000 lbs. and 17,000 lbs. on truck wheel. His heavy passenger engines have 18-in. × 24-in. cylinders, 62 in. wheels, 8 ft. rigid and 22 ft. 4 in. total wheel base. Weight on drivers, 67,800 lbs., and 103,000 lbs. total.

Repair bills on these engines are very light. He removes his tires by means of a portable gas apparatus.

Water for supply of shops at North Paterson comes from a deep well, and produces a very white, light, porous scale. This is kept from accumulating by occasional application through the injector of ordinary refined petroleum. The scale closely resembles the scale produced by the artesian water of Savannah, Ga.

He uses asbestos covering to his boilers, and fails to find any corrosion of the surface of the boiler plates even after a service of many years.

Has some Smith exhaust pipes, which do very well. In one case it enabled him to retain in service a switching engine of which the exhaust had been complained of as making much noise by the residents of the neighborhood. By changing the pipes all complaint ceased, and no other change to the engine was required.

DELAWARE, LACKAWANNA & WESTERN RAILROAD, KINGSLAND SHOPS.

Mr. Lewis takes care of 169 engines at this shop, where there are only nine pits in the erecting shop. He is in hopes that in the near future an additional shop will be built between the present transfer table tracks and the roundhouse, which will relieve the present crowded floor space and give him an opportunity to put in some wood-working machines, of which he has none. In addition to the locomotives, he has two tug boats and several barges, with their hoisting machinery, to keep in order, the switch work of the road department, and the Pintsch gas plant maintenance and repair. To furnish compressed air for the numerous hoists in the shop, as well as the two pneumatic hammers, he has a Pedrick & Ayer compressor, operated by belt, and giving very good results. By automatic regulator the belt is thrown off and on as the required pressure is obtained or lost. Has stopped trouble from leaking lower joints of steam pipes by using four instead of two bolts through lower flange. Is applying Gould couplers to front end of all engines and back ends of all tenders. Uses both single and double nozzles, placing the top of the former 23 in. and the latter 21 in. below the top of smoke arch. Uses Krupp tires almost exclusively, and when new they are 3½ in. and 4 in. in thickness. Has 40 or 50 engines equipped with the Rushford feed-water heater, which gives no trouble and saves fuel. A Niles turret-headed lathe is very highly spoken of; will take 2 in. round iron. Sellers' spiral motion planer with very quick return motion is also very highly commended.

CENTRAL RAILROAD OF NEW JERSEY.

The new model of the Smillie coupler with face knuckle and square shank is being applied to the 500 new coal cars of 60,000 lbs. capacity which this company are now getting.

PROCEEDINGS OF SOCIETIES.

The New England Railroad Club.—The evening for holding the regular meetings of this Club has been changed from the second Wednesday to the second Tuesday of each month. The meetings are held in the evenings at eight o'clock.

Civil Engineers' Society of St. Paul.—At the meeting of November 14 Mr. Hilgard illustrated the method of hydraulic grading in vogue on the Northern Pacific Railroad system. Under favorable circumstances the work of replacing worn-out wooden trestles with embankments is done at a cost of five cents per cubic yard.

The National Association of Manufacturers.—The time for holding the annual convention of this association has been postponed to Tuesday, January 21, 1896, and will be held at Chicago. The reasons given for the postponement are that the experience in organizing a constituency for the convention has developed a work of greater magnitude than was originally anticipated, and that the period in which the work of organization was undertaken has been largely taken up in political matters.

Liverpool Engineering Society.—At the meeting of October 30 Mr. Arthur J. Maginnis, the President, gave some interesting figures regarding the actual performances of cargo steamers at sea. He said that the following results have, at the various periods stated, been obtained from the consumption of 1 lb. of coal:

In 1840	1 lb.	coal	propelled	.578	{ displacement tons }	8	knots	with	.057	tons	{ earning weight
" 1850	"	"	"	.6	"	9	"	"	.16	"	"
" 1860	"	"	"	.83	"	10	"	"	.27	"	"
" 1870	"	"	"	1.8	"	10	"	"	.9	"	"
" 1880	"	"	"	2 1	"	10	"	"	1.05	"	"
" 1890	"	"	"	3.23	"	10	"	"	1.93	"	"
" 1895	"	"	"	3.4	"	8	"	"	2	"	"

Convention of the American Society of Mechanical Engineers.—The order of proceedings of this meeting, which will be held in the society's house at No. 12 West Thirty-first Street, New York, December 3–6, has been issued by the Secretary. At the first day's session the following topical questions will be discussed:

For filtering oil having very finely divided metallic particles in suspension, what have you found to be the best filtering material, either for one operation or in a series?

What information can you give as to the best method for the extraction of oil from condensed steam, where it is desirable to use the exhaust steam repeatedly for boiler feed purposes?

What is the economy, if any, of damper regulation in firing with liquid or gaseous fuel?

In boilers fired with liquid or gaseous fuel, is there any advantage in simultaneous regulation of the fuel supply and the position of the damper, either by the same or by different mechanisms, under the ordinary control of the steam pressure?

Are there any conditions under which oil fuel is cheaper than coal for generating steam at points in the Atlantic seaboard States; if so, what are they, and where?

Is an air chamber of any value on a duplex boiler feed pump of 4 in. to 6 in. stroke?

Has any member had experience in planning a successful working system of classification which is better than the Dewey system for books in an engineering library?

In a centrifugal pump at constant speed, how is the efficiency effected (*a*) by throttling the delivery; (*b*) by a by-pass?

In a centrifugal pump receiving water under a head, does the whole amount of the head add to its normal lift?

What is the common method and best practice for determining the largest sizes of pipe desirable to use in mill heating, both by live and exhaust steam.

In the operation of annealing tool steel, what is the essential or principal condition to be observed to insure the best success?

What rule is there for determining approximately the H.P. required to drive disk fans for exhausting and ventilating?

Has any one found it to pay to exhibit in recent international expositions, where to do so entails a cost of attendance, transportation and other heavy charges?

Is there any reliable method for calculating the cost of one machine, if the cost of a larger number is known; or, conversely, if you know the cost of one machine, can the cost of building a larger number of the same machine be satisfactorily calculated?

Has any term ever been suggested to discriminate between the elastic resistance offered by a body to a force tending to change its shape and that offered by the same body to a force tending to change its volume? How much of the latter kind of elasticity has india-rubber?

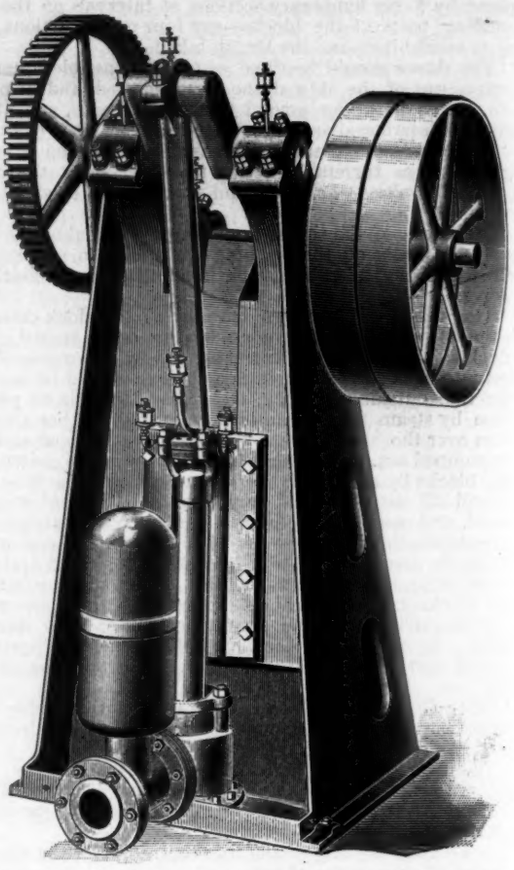
On succeeding days the following papers will be presented and discussed: Water Power of Caratunk Falls, Kennebec River, Me., by Samuel McElroy; Water Power, its Generation and Transmission, by Samuel Webber; Means adopted for Saving Oil in a Large Oil Refinery, by C. E. Emery; The Reliability of Throttling Calorimeters, by James E. Denton; Some Experiments with the Throttling Calorimeter, by A. A. Goubert and E. H. Peabody; Comparative Tests of Steam Boilers with different Kinds of Coal, by C. E. Emery; Experiments on the Friction of Screws, by Albert Kingsbury; Tests of a 10-H.P. De Laval Steam Turbine, by W. F. M. Goss; Recording Device for Testing Machines, by George W. Bissell; Effect of Temperature on the Strength of Wrought Iron and Steel, by R. C. Carpenter; Some Data relating to Forge Shop Design, by P. M. Chamberlain; Experimental Method of Determining the Effective Centre of the Light Emitted from a Standard Photometric Burner, by D. S. Jacobus; The Proportions of High-Speed Engines, by John H. Barr.

A reception and conversazione will be held for members and their ladies at Delmonico's, Twenty-sixth Street and Fifth Avenue, on Thursday evening at 9 P.M.

DIFFERENTIAL POWER WORKING HEAD FOR DEEP-WELL PUMPS.

THE Baldwinsville Centrifugal Pump Works, of Syracuse, N. Y., are manufacturing a very compact and powerful head for working deep-well pumps. As they are situated at the centre of the salt industry of New York State, this head is a natural development due to the requirements of the salt manufacturers. It is driven by a belt running on a tight and loose pulley that are on the lower shaft which runs back of the head and carries a pinion meshing in with the gear shown at the left. It is fitted with crosshead and adjustable guides, and is fitted with cut gears, steel crank, and is a strong, neat, and compact outfit intended for heavy and constant work. It is so arranged that by disconnecting the cross-head the connecting-rod can be thrown back out of the way, and by disconnecting the discharge casting the plunger or piston of the working barrel can be withdrawn without moving the working head from its foundation.

The special points of excellence of this machine are that the main frame is a solid casting instead of being built up; that it is provided with cross-head and adjustable guides; that the differential plunger is suificiently large to be easily packed and kept packed, and the fact that this cross-head runs in guides prevents any side motion, and thus the stuffing-box is always tight. These points, together with the fact that the working part of the pump can be withdrawn without removing the



DIFFERENTIAL POWER WORKING HEAD FOR DEEP-WELL PUMPS.

pump from its base or disconnecting the suction-pipe, makes it a very complete outfit. These heads are furnished in sizes varying from 12 in. to 24 in. stroke.

Recent Patents.

PAGÄN'S PROPELLER.

THE object aimed at by the inventor of this improvement is to so construct a screw propeller that it will draw the full supply of water necessary for its area of blade surface only from the direction in which the vessel is advancing. "This object," he says, "I attain by making a hollow hub, so as to destroy the vacuum that is found in propellers now in general use." From the side view (fig. 2) it will be seen that a plate or boss. B', is attached to the propeller shaft D. Another plate, B^2, which has an opening, b', in its centre is placed some distance from B' and the lugs or bosses on the inner ends of the propeller blades A A are fastened between these two plates by bolts C C. The blades are prevented from turning by lugs b b on the plates which enter corresponding cavities in the propeller blades. This leaves a hollow opening at B, into which the water can flow through the spaces b^2 b^2 between the bosses of the propeller blades, and can escape through the opening b'. The inventor is O. Pagän, of Philadelphia. The patent is dated October 29, 1895, and the number is 548,655.

PIERPOINT'S WATER-TUBE BOILER.

From fig. 3 it will be seen that this consists of an upper steam and water-drum, 2, a lower mud-drum, 3, a bank of tubes, 4, connecting these drums, and a partition wall, 5, located between the tubes of the bank and arranged to cause an up-and-down pass of the furnace gases over the tubes, and by keeping certain of the tubes in a cooler place insure a strong circulation and efficient abstraction of heat.

6 is the furnace, from whence the gases pass upwardly among the front rows of the bank, then descend among the

rear rows, and thence ascend through the outlet flue 7. Deflecting plates 8 are employed to hold the gases in contact with the tubes, thus insuring the abstraction of heat thereby.

In the steam and water-drum I provide a vertical longitudinal baffle-plate, 9, which is preferably bolted to the inside of the shell by angle irons 10 at the ends and extends upwardly to a point above the water-level. This plate extends between

FIG. 1.

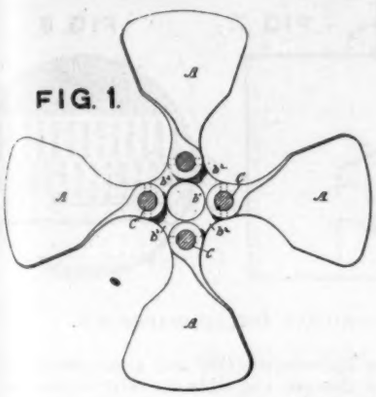
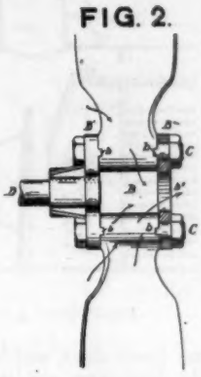


FIG. 2.



PAGAN'S PROPELLER.

the tube ends, and the feed-water entering through the pipe 11 on the left-hand side of the plate is prevented thereby from mingling with the hotter water rising through the tubes nearer the furnace, but descends through the rear rows in a less violent manner than in the main circuit, from which it is cut off by the baffle plate, thereby giving a much better deposition of sediment.

The inventor, Mr. James Pierpoint, of Pittsburgh, says:

"The heat of the gases is fully extracted on account of the lower temperature of the rear tubes down which the feed-water passes, while a violent circulation takes place between the front rows and these rear rows, which are not cut off by the baffle-plate."

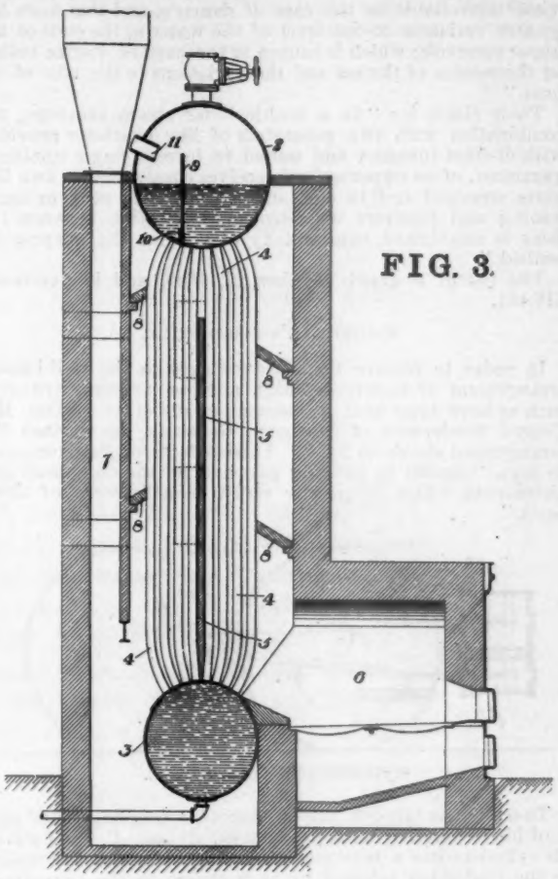
The patent is dated October 22, and numbered 548,455.

NORMAND & SIGANDY'S WATER-TUBE BOILER.

Messrs. Jacques Augustine Normand and Pierre Sigandy, of Havre, France, have patented in this country the improvement in the celebrated Normand boiler shown by figs. 4 and 5, which consists in connecting two such boilers together and working them in couples. Fig. 4 shows a sectional view of one such boiler and part of another, the upper or steam-drums *C C'* of which are coupled together by the connections *M* and *N*, and the lower or water-drums *B B'* are united together at

volume of water which the said generators contain. In multitubular steam generators so constructed, however—in particular in the marine type—variations in pressure are very considerable; so that, when several generators are coupled together

FIG. 3.



PIERPOINT'S WATER-TUBE BOILER.

for supplying steam to one engine the regular distribution of the feed-water to the different boilers gives place to serious difficulties, since the water has a tendency to enter the boilers where the pressure is lowest and where the discharge is conse-

FIG. 4.

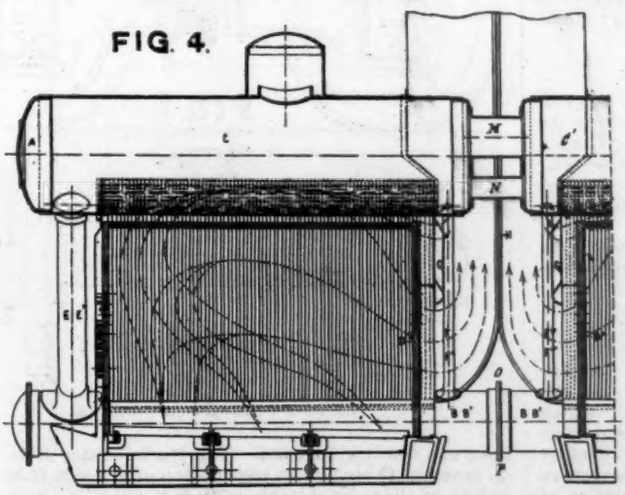
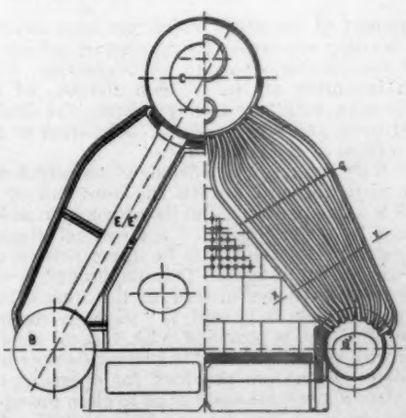


FIG. 5



NORMAND & SIGANDY'S WATER-TUBE BOILER.

O P. Fig. 5 is a transverse section of one of these boilers of the usual form.

In explaining their invention, the patentees say:

"The lightness of multitubular steam generators in which water circulates through the tubes is chiefly due to the small

quently the smallest. It would, therefore, seem useful to diminish as much as possible the number of generators thus coupled together, since the work and supervision which a regular distribution demands would be diminished in like proportion. There are, moreover, advantages gained by the use of

coupled generators, more especially in respect of the pipes, the cocks and valves, the reduction of temperature of the compartments, and the spaces occupied by the generators, which, in the case where several generators are in use, outweigh the disadvantages, such as that two generators instead of one become unavailable in the case of damage, and that there is a greater variation of the level of the water at the ends of the upper reservoir, which is caused in the case of marine boilers by the motion of the sea and the variations in the trim of the boat."

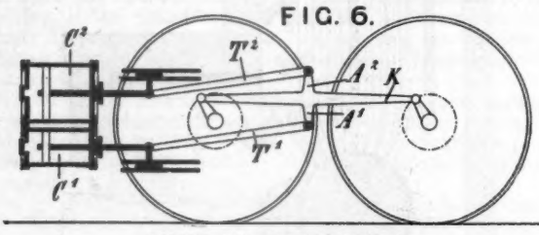
Their claim is: "In a multitubular steam generator, the combination with two generators of like character provided with distinct furnaces and united to form a single combined generator, of an upper central receiver constructed in two like parts arranged end to end, and a contracted neck or necks joining said receivers whereby communication between the same is established, substantially as and for the purpose described."

The patent is dated October 22, 1895, and is numbered 548,451.

SONDERMAN'S LOCOMOTIVE.

In order to remove the disadvantages in the well-known arrangement of superposed high and low pressure cylinders such as have been used in locomotive and other engines, Mr. Conrad Sonderman, of Stuttgart, Germany, has devised the arrangement shown in fig. 6. These defects, or disadvantages, he says, "consist in pending moments on the cross-head and piston-rods which frequently result in a fracture of these parts."

FIG. 6.



SONDERMAN'S LOCOMOTIVE.

To overcome this difficulty he makes the coupling-rod K (fig. 6) of his locomotive with projections, A^2 and A', and each of his cylinders has a separate connecting-rod which is coupled to the projection referred to, as is shown in the engraving. By this means, he says, the pressures on the two pistons are transmitted to the two crank pins simultaneously in an advantageous manner, the connecting-rods T^2 and T', the coupling-rod K and its bearings are all arranged in one vertical plane.

He says, further, that the cross-heads may be arranged above and below the piston-rods, as shown, or between them or a single cross-head, for the two cylinders may be used. Other methods of applying the same principle are also described.

The patent is dated October 25, and is numbered 547,899.

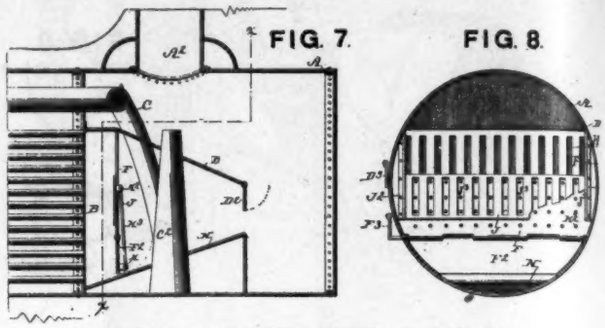
BRITTON'S LOCOMOTIVE BOILER DIAPHRAGM.

The amount of ingenuity which has been and can be exercised in devising appliances for regulating and controlling the draft of locomotives seems to be boundless. Figs. 7 and 8 show an invention of Mr. William Britton, of Boone, Ia., which, he says, will "accurately control the drafts through the boiler tubes and prevent the accumulation of ashes immediately in front of the lower tubes."

D and N are converging deflector plates which extend from the tube-plate forward toward the front end of the smoke-box. D^2 is a damper hinged at its upper edge and adapted to be operated by the engineer. F is a vertical diaphragm having elongated perforations H in its upper portion and circular holes H^2, as shown in fig. 8. This diaphragm, as will be seen, is placed a short distance in front of the front tubes. J indicates a plate which, it is said, is "slidingly mounted on the rear face of F, and is provided with vertical slots J^2" which alternate with those in F. F^2 is another damper hinged at its upper edge Means are provided for operating this damper and the plate J synchronously so as to close the upper slots in the diaphragm when the damper F^2 is opened. A portion of the draft is permitted to pass through the central perforations in the diaphragm at all times, and the fire in combustion chamber of the locomotive may be made to burn better toward the front of the chamber by closing the damper and lowering the slide J, thus permitting the greater part of the products of combustion to pass through the upper boiler flues, and if it is desired to make the fire burn better in the rear of the combustion-chamber the dampers are arranged so that the greater part of the products of combustion will pass through the lower flues, and this may be accomplished by the movement of a single lever.

By the arrangement of the deflector D, the damper D^2 and the inclined plate N the draft through all of the boiler flues may be regulated and the ashes prevented from stopping up

FIG. 7. FIG. 8.



BRITTON'S LOCOMOTIVE BOILER DIAPHRAGM.

the lower flues, and by the construction and arrangement of the diaphragm and the damper and slide the relative amount of draft passing through any section of boiler flue may be readily and quickly controlled.

The date of the patent is November 5, and its number 549,225.

CLIFF'S FREIGHT-CAR TRUCK.

The introduction of the Fox pressed-steel truck seems to have stimulated the inventive faculties of car-builders in devising some substitute for it. Figs. 9 and 10 represent a form of truck recently patented by Mr. Edward Cliff, of Newark, N. J. The frame of this is to be made preferably of iron or steel, forged or cast, and is made of an I sectional form, as shown at b'' of fig. 10. The frame, as will be seen, is made with an open-mouthed jaw at each end to admit the journal-box. Each jaw is closed by a removable bar, H', which is fastened by bolts J and K at its upper and lower ends. The jaws are made deep enough to receive a coiled or other spring, H, above the box. This has a central bolt, i, which passes through the truck frame. By screwing up the nut on this bolt the tension of the spring is taken off of the box, and by removing one of the bolts J or K the bar H' can be swung

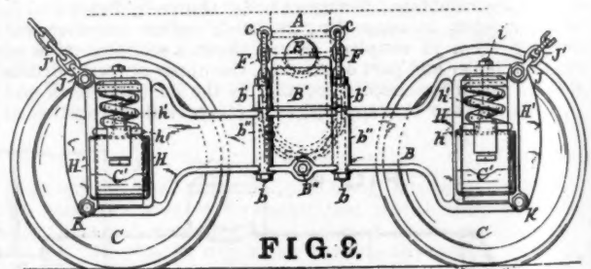


FIG. 9.

FIG. 10.

CLIFF'S FREIGHT-CAR TRUCK.

open and the box removed. The truck bolster B' is made of an inverted ∩ shape and rests on top of the side frames and is bolted to them by suitable lugs, b' b' and b'' b'', and with the bolts b b. Instead of having a centre pin, the upper and lower centre plates are made with suitable cup-shaped cavities and are provided with a metal ball on which the car body rests and can roll. The cavities being made somewhat larger than the ball, the body and the truck can move slightly in relation to each other. The patent is dated October 29, and is numbered 548,827.

ASSOCIATION OF AMERICAN RAILROADS
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TRANSPORTATION BUILDING
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March 15, 1944

Dear Professor Worley:

Regarding the matter of publication periods of the American Engineer and Railroad Journal in 1895 and 1896, you are quite correct in assuming the change from October as a monthly to a bi-monthly in November and December. The confusing matter is that there are three numbers dated November, viz one, fourteen, and twenty-eight, and only one December twelve, which makes it fortnightly rather than bi-monthly, but keeps numbers to fourteen for the entire year. An examination of the index fails to disclose any reference beyond page 580.

Although our file for 1896 lacks the number for February, they are all monthly quartos.

Yours very truly,

R H Johnston

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